EMPLOYING BRANCHING COMICS TO DESIGN, VISUALISE AND EVALUATE INTERACTIVE STORIES

by

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ABSTRACT

This thesis presents the case for adopting comics in the design, visualisation and evaluation of interactive stories. The potential for comics to be employed in the representation of interactive story-driven material has been identified in previous work. However, there is a lack of theory or evidence upon which an informed approach can be based. Consequently, this thesis contributes a process for employing branching comics to design and visualise interactive stories informed by previous approaches to stories, interactive stories and visualisations. It is argued that comics have several advantages over previous methods of designing interactive stories due to their inherent structural compatibility with visualising hierarchies of abstraction of story content. A series of studies are conducted to demonstrate how comics can be employed to visualise abstraction levels, and how branching comics can be employed to evaluate interactive stories. Qualitative and quantitative methods related to both user experience and comprehension are employed, which demonstrate the advantages in the use of comics to explore a range of different phenomena related to creating, interpreting and using interactive stories.

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CHAPTER 1: INTRODUCTION

1.1 – Research Questions

The focus of this thesis is on the design, visualisation and evaluation of interactive stories. Interactive stories can take many different forms, as will be discussed. Of particular interest in this thesis is the development of digital interactive stories, in which users can make choices that result in different routes through stories and experiences of different narratives. In order to manage the designs of interactive stories and the range of choices available to users, the thesis proposes the use of comics as interactive story visualisations. The potential for comics to present stories and other narrative-driven information with which users can interact has previously been identified by numerous authors and practitioners (McCloud, 1993, 2000; Gershon and Page, 2001; Gravett et al., 2003; Lu and Shen, 2008; Segel and Heer, 2010; Ma et al., 2012), and it is demonstrated in the thesis that there are links between approaches to designing and evaluating interactive stories, visualisations and comics. Yet, there is a limited amount of work that explores the potential for comics to be employed in interactive story development, in spite of the overlap between related theories. The crossover between approaches to comics, visualisations, stories and interactive stories consequently prompts a series of investigations into the following research questions:

1. "Can comics be employed to design interactive stories?"
2. "Can comics be employed to visualise interactive stories?"
3. "Can comics be employed to evaluate interactive stories?"
4. "Are there advantages to using comics to design, visualise and evaluate interactive stories, and if so, what are they?"

The thesis responds to the first two questions by linking related theories, which inform a novel approach to designing and visualising interactive stories through comics. The third question is answered through evaluations of interactive comics informed by this approach, and incorporating previous methods to evaluating stories, interactive stories, and visualisations. In response to the final question, it is argued that the results from these investigations show that comics have both potential advantages and limitations when employed to design, visualise and evaluate interactive stories.

1.2 – Contributions

1.2.1 – Designing and Visualising Interactive Stories through Comics

It is difficult to comprehend human activity without stories in some form, and understanding stories could be seen as a way of understanding ourselves (Boyd, 2009). Certain theorists have adopted this position to the study of stories; attempting to identify patterns within stories that reflect processes of human cognition (Aristotle and Heath, 1996; Todorov, 1969; Barthes, 1975; Rumelhart, 1975, 1980; Schank, 1995; Bortolussi and Dixon, 2003; Boyd, 2009). To varying degrees, these approaches take into account the content, presentation and reception of stories, and the complex cognitive activities that occur between their creators and consumers. Yet the methods of presenting and participating in stories that are interactive add additional complexities that present design challenges to creators attempting to balance the content and participation in, and presentation of, interactive stories (Louchart and Aylett, 2004; Adams and Rollings, 2007; Miller, 2008; Aylett et al., 2008a). These challenges have been explored in theoretical and practical guidelines in both academic (Mateas, 2001; Louchart and Aylett, 2004; Aylett et al., 2011; Stern, 2013) and mainstream presses (Adams and Rollings, 2007; Bateman, 2007; Miller, 2008; Lebowitz and Klug, 2011; Crawford, 2012). This thesis identifies and

discusses the overlap between these theories and those of the visual structures of comics for the purposes of contributing comics as a design tool for interactive story development.

In Chapters 2 and 3, the thesis explores the potential merits of comics in response to Research Questions 1 and 2 as described in Section 1.1. In particular, the visual layout of comics is explored in relation to notions of levels of abstraction, variables and combinatorial explosion. Levels of abstraction can be conceived as hierarchies of story content that contain abstract concepts, functions or information at the top and highly specific details at the bottom, with different levels of abstraction in between. In interactive story design, information can be assigned to different levels of abstraction to help identify where, when and how users can interact with a story, and the impact interactions would have upon the story at different levels (Aylett et al., 2008a, 2008b; Crawford, 2012). Variables can be simply conceived as conditions of stories that can change through interactions (Adams and Rollings, 2007; Crawford, 2012). Combinatorial explosion is a design problem associated with branching interactive stories, where the combination of possible subdivisions in plots can rapidly multiply following each branch point (Adams and Rollings, 2007; Crawford, 2012; Stern, 2013). This is explained in more depth in Section 1.3.9. In the thesis, it is shown that the complex relationship between the composition and layout of panels in comics can be employed to visualise variables and hierarchies of abstraction, and manage combinatorial explosions by imposing visual restrictions upon the multiplications. In response to Research Question 4, it is argued that these are unique aspects of comics, and facilitate the processes of designing branching interactive stories. The thesis therefore contributes theoretical and practical approaches to designing and visualising branching interactive stories, based upon the visual and narrative structures of comics.

1.2.2 – Evaluating Interactive Stories through Comics

The approaches explored in Chapter 2 illustrate that attempts have been made to incorporate understandings of user responses to interactive stories in theoretical models, whereas the approach using comics presented in this thesis focusses upon the content of interactive stories. Nevertheless, it is argued that comics can be employed to evaluate interactive stories, the results of which can inform the designs of both content and interfaces. In Chapter 4, the thesis explores previous methods and approaches to evaluating stories, interactive stories and visualisations. It is shown that studies into story comprehension map responses to stories against pre-defined structures. Regarding interactive stories, it is shown that previous studies employ similar methods but are predominantly focussed upon user experiences, possibly at the expense of understanding the correlation between interactions and comprehension. In response to Research Question 3, and referring to studies of visualisations, it is argued that an approach wherein responses to interactive comics are mapped against the comics themselves and related to levels of abstraction could be applied to analyse patterns in recollections of interactive stories, and be compared with experiences. It is argued that this approach provides several advantages over theories that may attempt to anticipate users' responses, and methods of evaluation that can be restricted to certain kinds of responses. In response to Research Question 4, Chapters 5 and 6 validate this argument as a contribution in the thesis by demonstrating the insights that can be obtained through visualisations of users' responses to strips of panels and interactive comics.

Chapters 7 and 8 build upon these insights, and continue to explore responses in which users collaborate to create and use interactive visual stories using a multi-user, multi-touch device in which levels of abstraction are physically divided. The visual structure of comics is manipulated to accommodate multiple users and/or readers simultaneously, allowing for data to be collected from participants delivering interpretations of comics and authoring their own comics in pairs

using frameworks provided. This is in keeping with theories of role-play in interactive stories discussed in Chapter 2, and it is argued that these theories can contribute to evaluations as well as designs. The employment of existing methods in protocol analysis and video observations help identify the different approaches groups take to using and creating interactive, branching comics. It is argued that the methods of both presenting and evaluating the stories help identify correlations between patterns of design and participation. The final contribution of the thesis, therefore, is the application of the visual structure of comics in multi-user environments to facilitate the designs, developments and analyses of interactive stories.

1.3 – Terminology and Concepts

In order to begin exploring processes in which interactive stories can be designed, visualised and evaluated through comics, it is important to clarify the terms used within this thesis in the context of the Research Questions and Contributions described above, and their associated concepts.

1.3.1 – Comics

This thesis proposes comics as a method of visualising, designing and evaluating interactive stories. The word ‘comic’ forms part of a portfolio of terms (such as ‘cartoon’, ‘graphic novel’, and ‘manga’) that have been used to describe sequential, panel-based art in which images and text are employed to convey a story (McCloud, 1993; Eisner, 2008a, 2008b). Comics are derived from the earliest forms of visual communication (McCloud, 1993; Cohn, 2013b), are an established form of visualisation (Gershon and Page, 2001; Segel and Heer, 2010) and can be used to represent forms that encourage the kinds of non-linear readings with which interactive stories are affiliated (McCloud, 1993, 2000; Goodbrey, 2013). Although presentations of text usually follow linear paths based upon cultural conventions, it is common

for comics to adopt a range of different layouts of pages, panels, illustrations and text to convey stories, which encourage non-linear approaches to reading (McCloud, 1993; Eisner, 2008a; Cohn, 2013a). The thesis explores this aspect of comics in relation to creating and using interactive stories.

1.3.2 – Authors, Designers and Creators

Due to the hybrid nature of comics and their interdisciplinary associations with writing text and composing illustrations (Eisner, 2008a, 2008b; McCloud, 1993), it could be argued that the term ‘author’ only partly encompasses the processes of creating comics. Therefore, the terms ‘design’ and ‘designer’ or ‘creator’ are preferred in the context of discussing the creation of comics in this thesis, interactive or otherwise. Even so, it is recognised that the terms ‘author’ and ‘authoring’ have been used extensively to discuss writing digital storytelling in previous work (Cavazza et al., 2001; Miller, 2008; Cheong et al., 2008; Tanenbaum et al., 2010; Dang et al., 2011; Louchart et al., 2013). Discussions of interactive technologies that can be story-driven are wide-ranging, and tend to employ the term ‘author’ and ‘designer’ interchangeably (Carroll, 1997, 2000; Bizzocchi and Woodbury, 2003), particularly in the context of writing for video games (Rouse III, 2005; Dickey, 2006; Adams and Rollings, 2007; Dille and Platten, 2007; Dickey, 2011). The thesis assumes story content is ‘authored’ and interactive content is ‘designed’ or ‘created’. However, it is recognised that this distinction may not be clear in many examples of interactive stories, in which case the terms ‘designer’ or ‘creator’ are preferred.

1.3.3 – Readers and Users

As is the case with the terms ‘author’ and ‘designer’, the terms ‘reader’ and ‘user’ may also be interchangeable in evaluations of interactive stories. Some studies of interactive fiction and hypertext stories, for example, refer to ‘readings’ of stories when they are, in fact, discussing

user experiences (Gee, 2001; Mangen, 2008; Pope, 2010; Mitchell and McGee, 2011). At the same time, the term ‘user’ has been used to refer to participants in reading activities of stories that explore comprehension rather than user experiences (Mandler and Johnson, 1977). As this thesis is concerned with both user experiences and comprehension, the terms ‘reader’ and ‘user’ will be used according to the phenomena being explored in relation to comprehension (reader), experiences (user) or both. As with authoring and designing, it is recognised that it may be difficult to distinguish between ‘readers’ and ‘users’ in many contexts, in which case the term ‘user’ is preferred.

1.3.4 – Visualise and Visualisation

Like comics, visualisations are a hybrid medium; using images as abstract representations of data, combined with text to clarify these representations to users (Gershon and Page, 2001). Visualisations can take many different forms depending upon the perceived requirements of users and suitability for the data being represented, as determined by designers (Segel and Heer, 2010). Rather than engaging the information linearly, visualisations can encourage users to examine information at an abstract, ‘overview’ level before exploring the specific details being visualised (Shneiderman, 1996; Gershon and Page, 2001). It has been previously argued that information visualisations could benefit from storytelling techniques and that comics could be explored as potential formats for representing data visually (Gershon and Page, 2001; Segel and Heer, 2010). The thesis explores this potential of comics in the context of interactive storytelling. It is argued that, if visualisations provide abstract, non-linear representations of information, then comics can visualise abstraction levels within interactive stories, and encourage users to explore stories at different levels in a non-linear fashion. Previous work in visualisations is also explored to discuss potential approaches to evaluating interactive story visualisations.

1.3.5 – Evaluate and Evaluation

This thesis proposes that branching comics can be employed to evaluate interactive stories. Previously, different kinds of evaluation have been employed to study stories, interactive stories and visualisations for different purposes. Evaluations of stories tend to explore the different compositions of stories and their impact upon readers' comprehensions in order to verify the existence of cognitive structures (Greimas, 1971; Brown, 1975; Black and Wilensky, 1979; Stein, 1982; Wilensky, 1983; Ryan, 2008b; Cohn et al., 2012). Many evaluations of interactive stories are more concerned with the methods by which users interact with them, and the impact these methods may have upon users' experiences of interactive stories (Gee, 2001; Knickmeyer and Mateas, 2005; Pope, 2010; Vermeulen et al., 2010; Mitchell and McGee, 2011). There are also studies of interactive visualizations that acknowledge the potential impact that interfaces could have upon understanding information, and incorporate evaluations of both user experiences and comprehension (Shneiderman, 1996; Ellis and Dix, 2006; North, 2006; Segel and Heer, 2010; Diakopoulos et al., 2011). In this thesis, the term 'evaluate' refers to the study of comprehension, user experience, or both, depending upon the context. Chapter 5 focusses exclusively upon comprehension, whereas Chapter 6 includes both comprehension and user experience studies. Chapters 7 and 8 demonstrate that user experience, comprehension and their interdependence in interactive stories can be measured simultaneously using a multi-user, multi-touch device and protocol analysis methods. These methods, as well as those employed in other studies, will be discussed in greater depth in Chapter 4.

1.3.6 – Story and Narrative

In this thesis, the terms 'narrative' and 'story' will be applied in ways that may not correspond with other approaches. Though the phrase 'interactive narrative' is commonly used throughout related work (Bizzocchi and Woodbury, 2003; Cheong et al., 2008; Tanenbaum et al., 2010;

Sali and Mateas, 2011), it has previously been identified that ‘narrative’ could be a problematic term, as different scholars can use it interchangeably with the term ‘story’; assigning different definitions depending upon the context (Ryan, 2008a). However, this thesis argues that distinguishing between the terms ‘narrative’ and ‘story’ could be beneficial in the context of defining interactive storytelling.

In Ryan’s (2008a) discussion of the term ‘narrative’, Abbot (2008) is cited as providing a definition of ‘narrative’ being the output of combining ‘story’ and ‘discourse’. In this context, ‘discourse’ refers to the interaction between author and reader through the representation, or narration, of a story, and its reading(s); which results in the creation of narrative(s). An interpretation of this could be that ‘story’ is an abstract collection of the elements that can be (re)arranged to make up a narrative, or, as Ryan states, “Narrative… is the textual actualisation of story, while story is narrative in a virtual form” (Ryan 2008a, p. 347). The position of this thesis is that this is a useful concept to apply to studies of the impact interaction could have upon stories as, in the context of interactive storytelling, stories are authored and interactions are designed, allowing users to create narratives through discourses of readings and experiences.

A similar approach is adopted by Wolff et al. for the development of interactive games, who cite Chatman (1978), Genette and Lewin (1980), Brooks (1996) and Szlias (1999) when claiming that, “The story is a collection of facts (such as events, actions, characters, etc.), whereas the narrative relates to the particular way in which these facts are arranged and conveyed to a reader or audience” (Wolff et al. 2007, p. 246). Though this description does not accommodate the creation of narratives through interactions as part of a discourse, it does contribute the division of stories into tangible components, described as ‘facts’, which can be arranged to inform narratives. This is another useful concept in the context of creating

interactive stories, where different elements of the story can be assigned to different levels of abstraction to determine the extent to which users can create narratives through the manipulation of story content (Aylett et al., 2008a, 2008b; Crawford, 2012). In this thesis, therefore, the term 'narrative' is used to describe both the structuring of story content and readings that emerge or are anticipated to emerge through interactions with stories. The term 'story' is used to describe the content created to inform these narratives.

1.3.7 – Interactive Stories

From the above definitions, the term 'interactive story' could be deemed to be problematic due to the range of possibilities it can encompass. Indeed, if notions of 'discourse' revolve around the interactions between authors and readers, then it could be argued that all stories are interactive. Nevertheless, there is a substantial body of work that defines interactive stories by the methods through which readers, users or participants interact with them. It is therefore important to distinguish between stories that are authored for consumption in a linear narrative sequence and those with presentations designed to be manipulated by readers, users or participants.

In the context of digital games, Adams and Rollings (2007, ch. 7) use the terms 'linear' and 'non-linear' to reflect this distinction. Yet non-linearity is not a characteristic of contemporary digital media or interactive stories only. Miller (2008), for example, cites the novels 'The Life and Opinions of Tristram Shandy, Gentlemen' (Sterne, 1996) and 'Ulysses' (Joyce, 2010) as being examples of books with linear sequences of pages that present story content in non-linear sequences. 'Composition No. 1' (Saporta et al., 2011) is a book that takes non-linearity even further, as its pages are unbound and readers are encouraged to view them in any order. However, regarding the navigation of story content, these experiences do not attempt to accommodate the desires of readers through enabling their actions to impact narratives beyond

the sequencing of events. On the other hand, Figure 1.3.7.1 shows an example of a Choose Your Own Adventure (CYOA) book, 'The Cave of Time' (Packard, 1982), and a point in its story at which the user is encouraged to choose whether the protagonist, whom the user represents, risks attempting to travel to the cave or not. CYOA books have therefore been cited as examples of interactive stories, as they not only present content in non-linear sequences, but also encourage users to navigate to pages that correspond with different possibilities in stories depending upon the choices and desires of their users (Miller, 2008; Segel and Heer, 2010; Sali and Mateas, 2011). Whilst the books described above could all be said to be non-linear, CYOA books offer experiences that differ considerably from other novels, and their designers must create a substantial amount of story content in anticipation of the different possible narratives that could be explored and/or constructed by their readers.

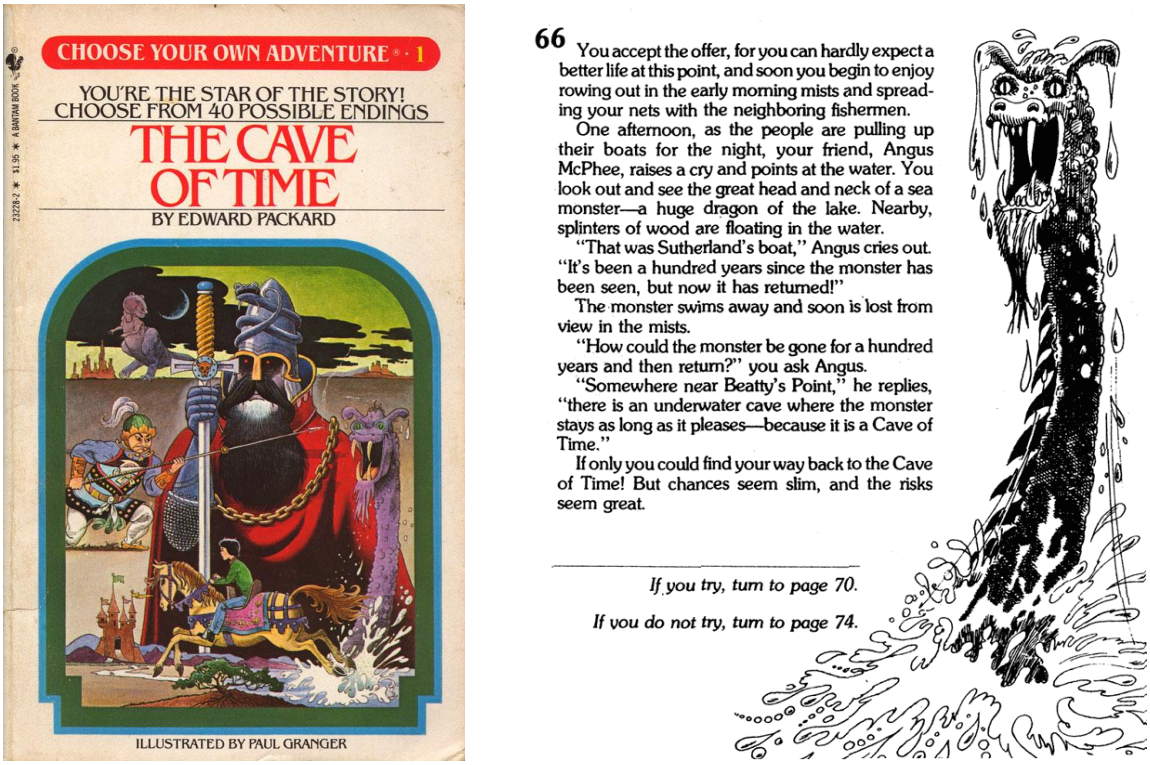


Figure 1.3.7.1 - A Choose Your Own Adventure book (Packard, 1982), and a point at which the user is encouraged to make a decision that impacts the narrative

When referring to interactive stories, such as CYOA books, the thesis is referring to stories that are designed through their content and presentation to encourage consumers to explore different possibilities in events themselves, rather than merely exploring the sequencing of events, thus creating highly variable narratives compared with other forms of stories. Many explorations of interactive stories assume their dissemination through digital technologies due to the perceived benefits of the associated media (Szilas, 1999; Bizzocchi and Woodbury, 2003; Louchart and Aylett, 2004; Brna, 2008; Tanenbaum et al., 2010; Louchart et al., 2013). In this thesis, interactive stories are also assumed to be digital unless stated otherwise. Nevertheless, the methods of creating and presenting interactive stories can take many forms, and it is important to further specify the scope of their exploration in the context of using branching comics to facilitate their designs and visualisations. In this context, the thesis distinguishes between two broad categories of interactive stories: those that employ 'branching' narratives, and those that employ 'emergent' narratives. Though it is argued that branching comics could facilitate the development of all interactive stories, the thesis recognises that comics are more suited to designing for branching narratives in interactive stories.

1.3.8 – Branching and Emergent Narratives

Adams and Rollings (2007, ch. 7) distinguish 'emergent' narratives from 'branching' narratives in the context of digital games design. It is argued that, in certain games or genres of games, the game mechanics, rules and software permit the players' narratives to emerge through interaction. The design of the game and its system's architecture permit these narratives to be created through play in real-time. These are 'emergent' narratives. 'Branching' narratives, on the other hand, depend upon pre-determined story content in order to accommodate the different options that players may choose within a game. Whilst emergent narratives employ systems to

create content in real-time, branching narratives depend upon story content that has already been created, and can be assigned to the decisions made by players in the game as events occur.

As demonstrated in relation to non-linearity in Section 1.3.6, emergent narratives also predate contemporary or digital media in various forms. Miller (2008), for example, argues that religious rituals and re-enactments, which date back to ancient times, are forms of emergent narratives, as oftentimes participants are encouraged to create story content as part of their roles and reactions during ceremonies. Slightly more structured forms of emergent narratives can be seen in improvisational theatre, wherein audience members can provide input to stories at certain points and actors are expected to adapt to these requirements during the course of the play (Aylett and Louchart, 2003; Louchart and Aylett, 2004; Miller, 2008). Such structures and mechanics have continued to evolve around these forms of participation in the form of table-top role-playing games such as Dungeons and Dragons, which have in turn been influential to approaches to digital storytelling (Rouse III, 2005; Miller, 2008; Aylett et al., 2008b; Crawford, 2012), and will be discussed in greater depth in Chapter 2.

By these definitions, therefore, CYOA books would be categorised under branching narratives, as the books contain pre-determined story content that readers navigate to, and that corresponds with different choices. By contrast, emergent narratives are reliant upon their participants' abilities to construct content that informs these narratives, or technical and software innovations that can simulate these activities, in real-time. As this thesis is concerned with design processes of interactive stories rather than storytelling systems, the present work is focussed upon branching narrative structures. It is the position of the thesis, however, that approaches to designing branching narratives can be influenced by explorations into emergent narratives, and that designing content for emergent narratives may pose similar challenges to those of designing branching narratives. It is shown in Chapter 2, for instance, that Aylett et al. (2008a, 2008b)

use the Game Master creating content in real-time during non-digital role-playing games as an analogy for artificial intelligence in interactive storytelling. Although this is deemed to be a form of emergent narrative, the possibilities are restricted within the confines of the requirements of the game's scenario, thus allowing for a manageable amount of story content to be programmable using equivalent digital systems. Therefore, though the branches themselves do not need to be pre-determined, the confines of a story's content must be pre-determined, and therefore designed, for emergent narratives. Though it is shown that they are more suited to branching narratives, the thesis argues that there is potential for comics to be employed to explore these confines in both branching and emergent narratives.

1.3.9 – Branch Points and Combinatorial Explosion

As suggested in their name, branching narratives contain 'branch points' where users can decide the direction the story goes next. Adams and Rollings describe a branch point as being "a place where the current plot line subdivides" (Adams and Rollings 2007, p. 196). In the Choose Your Own Adventure book shown in Figure 1.3.7.1, the branch point is described at the end of the page on the left, where the reader can choose whether to attempt to go to the cave or not. From Crawford (2012, p. 116), Figure 1.3.9.1 illustrates the problems inherent in designing and using branches in stories that involve these subdivisions of story content. As Crawford states, "Branching trees suffer from geometric growth that always requires more work than designers anticipate" (Crawford 2012, p. 117). The cover of the Choose Your Own Adventure book to the right of Figure 1.3.7.1, for example, states that the story has forty possible endings. Figure 1.3.9.1 demonstrates how this is possible by showing a single point subdividing into two possible branches, which each lead to branch points that divide into two more branches each, and so on. The pattern repeats until the fifth level of subdivisions that can occur has resulted in thirty-two possible outcomes. Adams and Rollings (2007, p. 199) and Stern (2013) use the term

‘combinatorial explosion’ to refer to the rapid multiplication of branch points that result from this ‘geometric growth’.

There are several possible approaches that can help designers control the amount of story content that must be produced to accommodate the flexibility of branching, such as ‘foldback’ structures (Adams and Rollings, 2007; Crawford, 2012) and ‘state variables’ (Crawford, 2012). These are discussed in Chapter 2, amongst other approaches to interactive storytelling. In Chapter 3, the thesis presents the case for employing comics to visualise such structures and variables, which can contribute to established design processes and have several advantages.

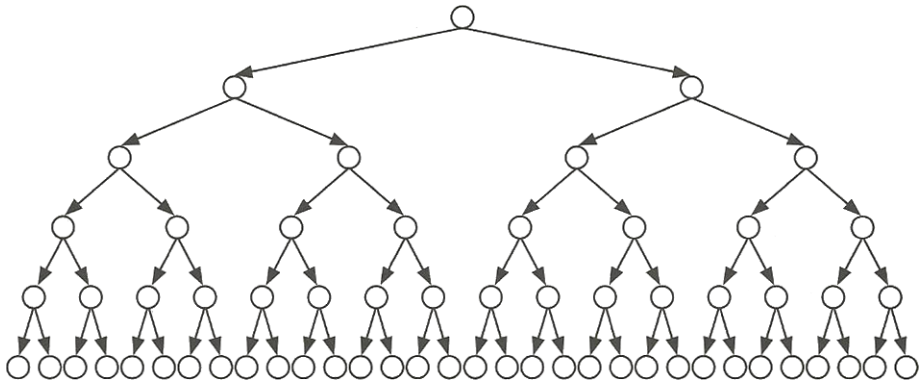


Figure 1.3.9.1 - A ‘branching tree’ structure (Crawford 2012, p. 116)

1.4 – Conclusion

The scope of this thesis is specified through its research questions, the concepts and terminology employed as defined within this chapter. In the context of investigating comics as a means of designing interactive stories, the thesis explores the role of the designer as the creator of story content rather than the creator of systems that perform this role in response to the actions of users. With this established, previous work that could inform design processes of interactive stories is explored in Chapter 2.

CHAPTER 2: APPROACHES TO DESIGNING INTERACTIVE STORIES

2.1 – Introduction

This thesis presents the case for employing comics to design, visualise and evaluate interactive stories in response to the research questions as set in Chapter 1. The current chapter provides an overview of approaches to designing interactive stories that can be related to the visualisation of story content, in preparation for the application of comics. It is argued that there are common aspects between approaches related to the hierarchies of content within stories, levels of abstraction in interactive stories, and foldback structures and variables in digital games. Although games are a specific form of interactive story, there are a number of guidelines related to designing the content of role-playing and other story-driven games that are related to theories of interactive stories. The benefits and limitations of each approach are described. Following this, these approaches are related to the visual structures of story grammars and schemata to demonstrate that there are common aspects related to the processes of creating story content and designing interactive branches through visual representations.

2.2 – Influential Theories in Interactive Stories

Although there are many theories of stories and storytelling, some approaches have had more influence upon interactive storytelling than others. Section 2.2 explores aspects of the influential theories that have been identified as relevant to interactive stories.

2.2.1 – Prehistoric (Interactive) Stories

As discussed in Chapter 1, participating in stories is not a new phenomenon, and the responses of participants within such stories have always impacted their presentations and interpretations (Aylett and Louchart, 2003; Louchart and Aylett, 2004; Miller, 2008; Crawford, 2012). In her

discussion of digital storytelling, Miller (2004, ch. 1) has shown that digital storytelling experiences can be related to religious ceremonies and re-enactments, which are probably prehistoric and continue to this day. These activities are performed in order to help initiate or reaffirm individual roles within their participants' corresponding groups or communities. This relates to the theories of Boyd (2009) and Crawford (2012) who argue that stories are an evolution of 'play', which can be seen in animal behaviour as a way of learning important skills for survival. In this respect, interactive stories have been associated with what some people believe to be prehistoric forms of storytelling, where there is an assumed level of participation that extends beyond what we may consider to be 'traditional' storytelling (Miller 2004, ch. 1), as discussed in the previous chapter.

2.2.2 – Aristotle and Interactive Drama

The earliest theories of stories can be seen in ancient times, though by contemporary standards these may be considered analyses of 'genres' of stories, rather than holistic approaches (Ryan, 2008a). Aristotle, for example, who lived from 384-322 BC, contributes the notion of plot through analyses of epic poetry (De Jong, 2008; Ryan, 2008a). In spite of its age, Aristotle's 'Poetics' (Aristotle and Heath, 1996) contains descriptions of form which have sustained resonance, such as the concept of stories having a beginning, middle and end, and continues to be used in guidelines for designing interactive story-driven media (Jacobs, 2007; Laurel, 1993; Mateas, 2001).

A prominent example of the application of Aristotle's theories in digital storytelling can be seen in the interactive drama 'Façade' (Mateas and Stern, 2003). In this program, the user embodies the role of a character invited to socialise with two friends who are romantically involved and sharing an apartment with one another, but happen to be engaged in an argument when the user's character arrives. In a story inspired by Edward Albee's (1965) 'Who's Afraid of

Virginia Woolf?', The user interacts with the three-dimensional virtual setting using a mouse and keyboard, and with the characters using natural language via a keyboard (see Figure 2.2.2.1).

In his explanation of the theoretical model for developing interactive drama that informed 'Façade', Mateas (2001) explores how Aristotle's theory of drama can be combined with Janet Murray's (2001) aesthetic criteria for interactive story experiences. These criteria are 'Immersion', 'Agency' and 'Transformation': feeling as if present in another place (immersion), empowered within it (agency), and participating in the transformations being experienced in the embodied character's journey (Murray, 2001). Mateas (2001) explains that, in Aristotle's model, audiences decode the form of a story through its presentation (which would equate to constructing a 'narrative' through the 'discourse', as discussed in Chapter 1), which is delivered by the characters within the story. In an interactive drama, the user takes control of one of the characters, allowing the user to construct their own narrative within the constraints of the formal requirements of the story at the level of 'plot', and by the possibilities afforded to them through both the interface and the other materials presented.

Figure 2.2.2.2 shows the Aristotelian theory of drama following Laurel's (1993) analysis in the context of human-computer interaction and Mateas' (2001) adaptation to interactive drama. This rendition illustrates the potential dilemma facing designers of interactive stories. In traditional dramas, audiences 'readings' of the 'formal cause' are delivered through the 'material cause' of the 'enactment'. If users can interact at the level of 'character', however, the material cause of their actions has to be restricted according to the plot, from above, and the material available for action, from below. From a design perspective, Figure 2.2.2.2 visualises this dilemma, as it represents both 'top-down' (design-led) and 'bottom-up' (user-led) approaches to creating interactive experiences.

Figure 2.2.2.1 - Mateas' and Stern's (2003) 'Façade'

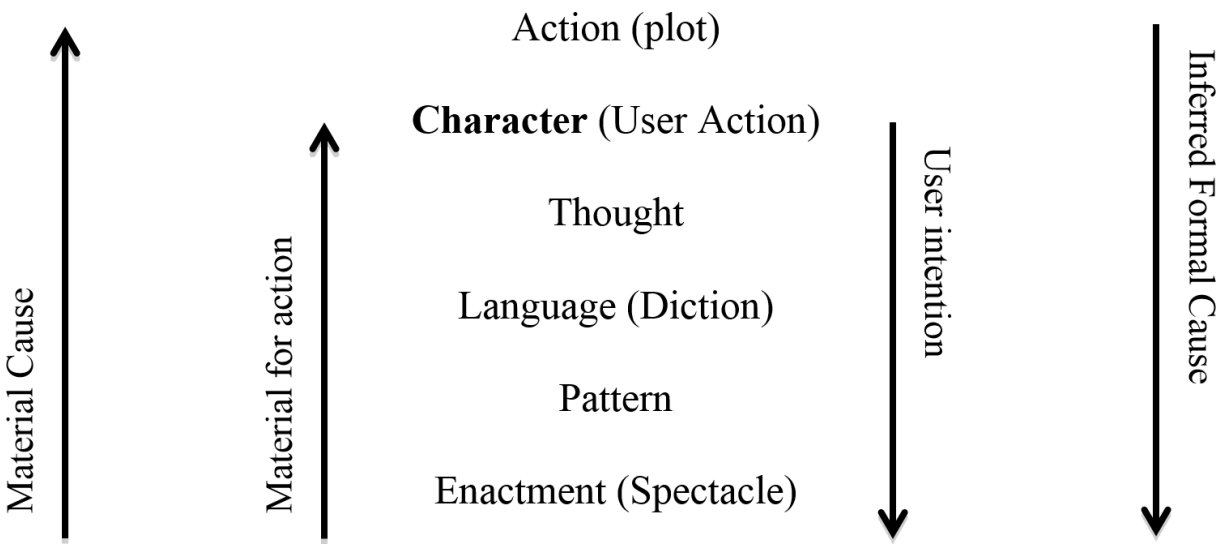


Figure 2.2.2.2 - An adaptation of Aristotelian theory for interactive drama (Mateas 2001, p. 144)

With this in consideration, Figure 2.2.2.3 shows a simplification of Mateas' (2001) 'Neo-Aristotelian' model adapted to reflect the considerations of creators of interactive stories against the possibilities afforded to their users to construct narratives. Here, the design is balanced with the intention(s) and interpretation(s) of the user(s), based on what is made possible through the material(s) and interface(s) provided. The beginnings of a visual representation of a hierarchy for developing interactive story content can therefore been seen in the work of Mateas (2001) and its adaptation in Figure 2.2.2.3, based upon balancing the requirements of creators and users. In spite of its framing, however, this approach can still lead to the combinatorial explosion of story content. Experiences like Façade, for example, although ground-breaking in terms of their artificial intelligence and natural language processing capabilities (Seif El-Nasr et al., 2013) require an enormous amount of content for their small scenarios (Stern, 2013), which may not be fully appreciated by users (Mitchell and McGee, 2011; Seif El-Nasr et al., 2013). This problem could be overcome by integrating approaches that deal with story content specifically into those that explore mechanisms for delivering and interacting with stories.

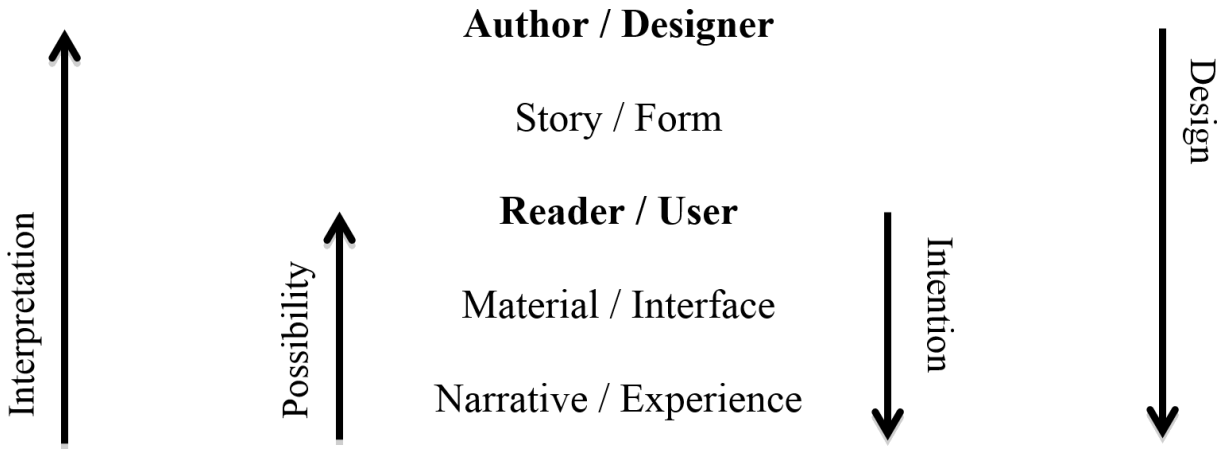


Figure 2.2.2.3 - Simplifying Mateas' (2001) 'Neo-Aristotelian' model to reflect considerations for creators and users of interactive stories

2.2.3 – Story Hierarchies (Formalism and Structuralism)

Aristotle has been said to be the first theorist to analyse form in the study of story composition (Margolin, 2008). Russian Formalism from the second and third decades of the twentieth century has subsequently influenced contemporary narrative theory (Herman et al., 2008). In particular, Vladimir Propp's (Propp and Wagner, 2010) work on Russian folktales has been used extensively in the development of computational models of storytelling (Louchart and Aylett, 2004; Finlayson, 2009; Abello et al., 2012). Through a study of particular genres of story, Propp breaks down folktales into a series of generic 'functions', which in turn contain related hierarchies of subclasses in order that they have universal application. Though not all functions appear in every story, Propp argues that they would appear chronologically and logically in every folktale, and that their definitions would help categorise and analyse the contents of stories. Demonstrating how this can be applied to computational models, Finlayson's (2009) 'Analogical Story Merging' uses morphologies derived from Propp and others in a model to validate the existence or otherwise of story frameworks by 'merging' stories to identify their structural differences and similarities along these morphologies. In this case, the model is applied to some simple stories as well as a set of Shakespeare's plays. Whilst the output of the models may be inconclusive, they at least serve to show the practical application of such hierarchical structures.

Following the Russian formalists, structuralists such as Barthes (1975, 1977) reintegrate discourse into the understanding of stories and their structures. Building on the work of the formalists as well as fellow structuralists, including Lévi-Strauss (1955), Greimas (1971) and Todorov (1969, 1977), Barthes builds a comprehensive theory around the content of stories, which includes consideration for the autonomy of the reader, as well as the universal consumption and range of methods of presenting or representing stories. In order to

accommodate the complexity of such a model and its universal application, stories are divided into hierarchies of elements, wherein actions and events are categorised according to their importance. According to Louchart and Aylett (2004), Barthes universal yet abstract approach makes it difficult to apply to computational models of storytelling, though this has been attempted in the past (Cavazza et al., 2001). The notion of subdividing stories into hierarchies, however, may be useful for the development of interactive stories where the story content intended to be delivered to users by designers needs to be balanced with the desires and capabilities of users, as discussed in Section 2.2.2. Table 2.2.3.1 shows a possible interpretation of this, where within a hierarchy of elements, the Story level of important actions or events fundamental to the intentions of the designer could be used to balance or direct actions or events at the Narrative level, according to the possibilities offered to the user. This relates to subsequent approaches to interactive storytelling in the context of games.

	AUTHOR / DESIGNER	**READER / USER**
STORY (HIERARCHY)	Important content	Low interaction
NARRATIVE (ELEMENT)	Minor content	High interaction

Table 2.2.3.1 - A simple overview of designing interactive story hierarchies according to the requirements of creators and users

2.3 – Stories and Games

If stories are derived from ‘play’, as argued by Boyd (2009) and Crawford (2012), then it is appropriate for games to be discussed in the context of interactive stories. Although it is matter of debate as to whether theories of games could, or should, be integrated with theories of narrative (Jenkins, 2008), studies of games have contributed some significant concepts to theories of interactive stories. These discussions have included consideration for the forms of games as well as the experiences they could offer, which can be related to the different kinds of content and experiences that can be presented in interactive stories. It is therefore appropriate to explore some relevant examples of theoretical approaches to games.

2.3.1 – Role-playing Games, Dungeons and Dragons and Abstraction Levels

Dungeons and Dragons is a specific example of a game of a specific genre; role-playing games (Adams and Rollings, 2007; Miller, 2008; Crawford, 2012). Yet it is worthwhile focusing upon this title due to its heritage and influence on approaches to interactive storytelling, as well as storytelling in games specifically (Rouse III, 2005; Adams and Rollings, 2007; Aylett et al., 2008b; Miller, 2008; Tychson et al., 2009; Crawford, 2012). In addition, role-playing is common mechanism of participation in interactive stories, including the examples of religious re-enactments (Miller, 2008), Choose Your Own Adventure books (Packard, 1982), and interactive drama (Mateas and Stern, 2003) explored so far.

Miller (2008) argues that the rituals and religious re-enactments discussed in Section 2.2.1 are precursors to contemporary role-playing games, as they involve participants taking on roles that facilitate their integration within established communities. Such re-enactments are also exploited in table-top war games during the eighteenth and nineteenth centuries for similar reasons. In keeping with the ceremonial re-enactments, these ‘simulations’ incorporate role-

play within their scenarios for the purposes of training potential commanding officers in battle strategies (Miller, 2008). The formula for table-top role-playing evolved into the format of 'Dungeons and Dragons' in the 1970s, which incorporates the role of the 'Dungeon Master'. Crawford (2012) argues that much of the pleasure to be had from participating in Dungeons and Dragons derives from the abilities of the Dungeon Master, as he or she has considerable control over the environment other players participate in, including the design of the dungeon, application of the rules, and the scenario itself.

It has been said that, because of this role, Dungeons and Dragons is more closely affiliated with improvisational theatre than other role-playing experiences, and therefore closely associated with interactive stories (Miller, 2008; Aylett et al., 2008b). This is because the human player that acted in the role of the Dungeon Master or Game Master (GM) creatively improvised responses to the actions of other players within the context of the scenario. As Rouse sates; "The Dungeon Master plans out in advance the locations the players will be exploring, has some idea of what characters the players will meet in what locations, and probably knows what major conflicts will be presented. The players, though, are in control of what parts of the level they investigate, and how they conduct themselves with the different NPCs [or Non-Player Characters] they meet" (Rouse 2005, p. 205). It is argued that the script for Non-Player Characters in 'Dungeons and Dragons' or similar table-top games is not necessarily written in advance by the GM, but the GM will know enough about the personalities of NPCs beforehand to guide conversations that other players will participate in (Rouse 2005, ch. 11). Therefore, games of Dungeons and Dragons are interactive stories, as all the players contribute to the emergence of narratives under the supervision of the GM.

As discussed in relation to emergent narratives in Chapter 1, one of the recognised problems of digital interactive stories is the production of story content in response to the actions of human

participants in real-time. By deconstructing the Dungeons and Dragons 'approach', Aylett et al. (2008a, 2008b) discuss the GM role as a potential model for solving this problem in digital storytelling systems due to its functions of restricting story content around predetermined requirements and controlling emergent narratives. These functions are organised into a hierarchy of decisions and represented as 'abstraction levels', which are reproduced in Table 2.3.1.1. The 'High level' of abstraction is the most abstract description, in this case: "The GM intends the player to gain information". As descriptions become more specific, decisions are made regarding who provides this information, the details of the interaction, and the circumstances. The highest levels of abstraction are fundamental to the requirements of the game and the story, as they determine the distribution of basic information. The lower the level of abstraction, the more freedom the players have to control how this information is distributed and subsequently contribute to the emergence of narratives.

High level	The GM intends the player to gain information
Abstraction level 2	GM decides bearer of information
Abstraction level 3	GM decides the details of interaction between players and bearer
Lower-level	When dies it happen? What is said by NPCs? What is the furniture, location?

Table 2.3.1.1 - Example abstraction levels, from Aylett et al. (2008a, p. 3)

In the context of interactive storytelling, abstraction levels are intended to facilitate the design of artificial intelligence systems that contribute to emergent narratives in response to users' actions, similar to Mateas' (2001) approach to interactive drama described in Section 2.2.2. However, the position of this thesis is that the concept of abstraction levels is also useful when designing the content of interactive stories, including those that employ branching narratives. The games designer Chris Crawford, for example, uses a similar analogy to the Game Master when describing a parent telling a child a story to illustrate how specific content can emerge through interaction (Rouse III 2005, ch. 11). As Rouse states; "The parent has in mind a story to tell including what characters it will involve, what surprises it will contain, roughly how the story will unfold, and approximately how it will end. But as the child asks questions about the story, the parent will change the tale accordingly" (Rouse III, p. 205). This results in additional details or information being narrated and possibly constructed by the parent in accordance with the child's wishes. It is argued that a successful model for interactive stories in videogames would adopt this approach, and respond to the player's wishes as they interact. This approach is very similar to that of the Game Master in the work of Aylett et al. (2008a, 2008b), but with a focus upon content, rather than functions, and without the application of abstraction levels.

Figure 2.3.1.1 demonstrates how levels of abstraction could be combined with Crawford's approach to story content as an evolution of the notions of hierarchies of interactive story experiences discussed in Section 2.2. Here, the abstraction levels divide elements of story content, rather than the functions related to the dissemination of information. In this case, important information fundamental to the story is contained within higher levels of abstraction, whilst less important information is more specific. The arrows indicate the direction of influence upon the experience by both designers and users. Those creating interactive stories will direct their influence from the higher levels of abstraction, where the fundamental

information is contained, down towards the user, whilst encouraging the user to create narratives at lower levels of abstraction as part of the experience of interacting with the story. Although lower levels of abstraction could still impact upper levels, the further the level is from the fundamental information required, the less impact it will have. This approach takes into account the abstraction level(s) at which designers require users to receive content balanced with level(s) at which its users' actions can lead to different branches in content, or cause new content to emerge. In the same way that abstraction levels can help determine the functions of a digital storytelling system, such hierarchies could also help developers create a predetermined story and decide where, how, and to what extent players can influence their own narrative experiences.

Although designers of interactive stories could benefit from separating the content and functions of their stories into abstraction levels, there are also some obvious limitations in this process as, by their nature, abstraction levels cannot be used to determine the specific functions or information that should go into them. It could be argued that this is an inevitable limitation, as it would be impossible to accommodate the different requirements of all the different designers and users of interactive stories. Nevertheless, in the context of digital games, similar approaches exist that incorporate more specific references to story content.

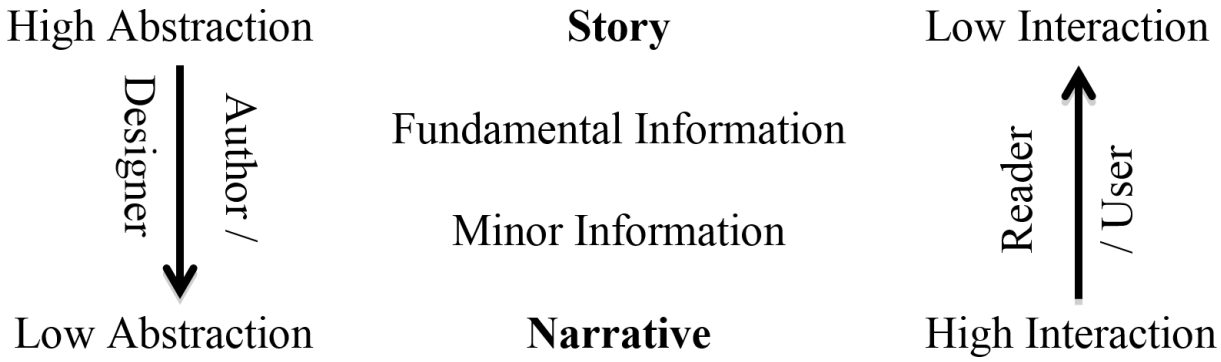


Figure 2.3.1.1 - A simple model of interactive story content based upon abstraction levels

2.3.2 – Story-driven Digital Games

There is a range of literature that argues the potential benefits stories can provide consumers of digital games due to the additional entertainment that stories can provide (Adams and Rollings 2007, ch. 7; Dille and Platten, 2007; Miller, 2008; Rouse III 2005, ch. 11). As Rouse III claims; "games certainly do not need stories, but it seems that when employed properly, stories can make games that much stronger" (Rouse III 2005, p. 203). Adams and Rollings (2007) argue that, although there are many types of games that do not contain story content, the mechanics of games can result in the emergence of narratives from the experiences being formed in the processes of playing them. It could therefore be argued that the distinction between the 'designers' and the 'players' of digital games reflects the distinction between the creators and users of interactive stories explored so far in the thesis, and their associated issues in terms of designs.

This is supported by other literature related to games design. Lebowitz and Klug (2011), for example, discuss the challenges of balancing authored content with interactive content in pursuit of a 'player-centred' approach to interactive story design. In keeping with this approach,

Rouse III (2005, ch. 11) argues that there are two types of story that can be experienced in a videogame: the 'Designer's Story' and the 'Player's Story'. The Designer's Story is the content that is delivered to the game player no matter what level of interaction is permitted, which can occur during non-interactive sequences, such as cut-scenes or non-player character dialogue sequences. The 'Player's Story', Rouse argues, involves the interaction that takes place instead of, or amongst, these sequences, and "is the most important story to be found in the game, since it is the story the player will be most involved with, and it is the story in which the player's decisions have the most impact" (Rouse III 2005, p. 204). By correlating the discussions of Adams and Rollings (2007), Rouse III (2005), Lebowitz and Klug (2011) and the other approaches covered in the thesis so far, it can be argued that the Player's Story is the equivalent of emergent narratives, and the interactions that are possible in the mechanics of games are the equivalent of discourses that create these narratives. Narratives created through the Designer's Story, on the other hand, depend upon predetermined story content to be delivered to players in relevant sequences, which can also be the result of certain interactions. Branching narratives are consequently implicit in digital games in which players can explore the Designer's Story.

The genres of digital games most closely affiliated with storytelling are role-playing games and adventure games, as they are most reliant upon the development of story content (Rouse III, 2005; Adams and Rollings, 2007; Lebowitz and Klug, 2011). Digital role-playing games are similar to those discussed in Section 2.3.1 but with digital storytelling systems in place of the human Game Masters that govern their players' progressions. To date, rather than employ the artificial intelligence systems proposed by Aylett et al. (2008a, 2008b) to create emergent narratives, most digital role-playing games employ branching narrative structures of varying complexity (Rouse III, 2005; Adams and Rollings, 2007; Lebowitz and Klug, 2011; Crawford, 2012). Adventure games and graphic adventures can be equated to the digital equivalent of the

Choose Your Own Adventure books discussed in the Chapter 1, often embellished with additional graphics, sounds, game mechanics and interfaces that are intertwined with both the progression and representation of their stories (Rouse III, 2005; Adams and Rollings, 2007). Both digital adventure games and role-playing games tend to incorporate different kinds of branching narratives, such as dialogue trees (Rouse III, 2005; Adams and Rollings, 2007; Miller, 2008), which are discussed separately in Section 2.3.4. There are many other genres of games, and hybrids of genres, which contain various proportions of story content in relation to the kinds of narratives that can emerge whilst playing them.

Hybrid genres of story-driven games do exist in non-digital media, such as 'Talisman of Death' by Jackson et al. (1985); which is part of a series of 'Fighting Fantasy' books that integrate game mechanics into the role-playing scenarios of Choose Your Own Adventure books (see Figure 2.3.2.1). With digital games, however, the range of possibilities to manipulate story content is greater due to the continuing technical advances in, and capabilities of, digital media. Examples of story-driven games that mix genres are Mass Effect (2009), which combines action and role-playing game mechanics (see Figure 2.3.2.2), and Heavy Rain (2010), which is an interactive drama with action and adventure traits (see Figure 2.3.2.3). Both of these games allow their players to explore and interact with virtual environments, and control the narrative direction of their stories to various extents. However, the growing complexities of contemporary games mean that producers have to take into account the cost of developing story content in addition to issues related to designing interactivity, meaning compromises need to be made (Adams and Rollings, 2007). The Choose Your Own Adventure book shown in Figure 1.3.7.1 of the previous chapter states on its cover that it has forty possible endings, which is advertised as a unique selling point to potential readers. Nevertheless, the potential benefits to readers is not made clear, and the number of endings is still reduced compared with the amount

that could emerge through unmanaged combinatorial explosions. Even so, if rendered with the equivalent graphics and sounds of Heavy Rain or Mass Effect, this number of endings could still be prohibitively expensive to reproduce in digital media. Such concerns have resulted in different approaches to reducing the cost and complexity of designing contemporary interactive stories.

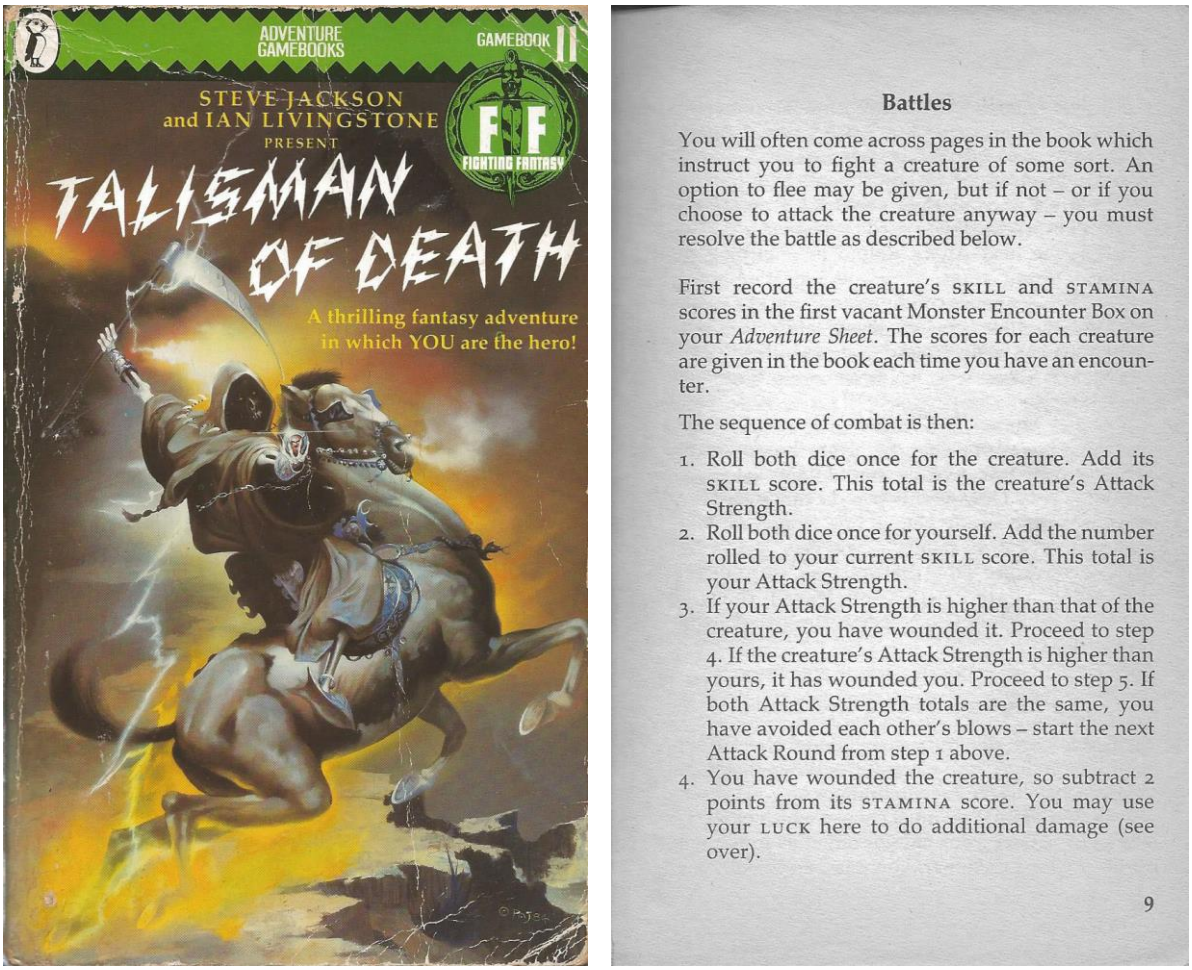


Figure 2.3.2.1 - An example of a 'Fighting Fantasy' book (Jackson et al., 1985), which incorporates role-playing game mechanics into the Choose Your Own Adventure format

Figure 2.3.2.2 - Example scenes from BioWare's (2009) Mass Effect, which contains role-playing and action game mechanics

Figure 2.3.2.3 - Example scenes from Quantic Dream's (2010) Heavy Rain, in which the player can control several characters in various ways

2.3.3 – Foldback Structures and Variables

A potential solution to the problems of cost and combinatorial explosion when developing branching content for digital games is the application of structures that have been termed ‘foldback’ by Adams and Rollings (2007, ch. 7), and Crawford (2012, ch. 8). It is argued by Adams and Rollings (2007, ch. 7) that foldback structures provide a compromise between branching and linear narratives. This approach is shown in Figure 2.3.3.1, which illustrates that the player can take various paths amongst branch points between ‘inevitable events’ that the game’s designer and/or ‘storytelling engine’ has determined must occur in order for the game to progress (Adams and Rollings 2007, ch. 7). This is achieved with story content that is flexible enough to allow the outcomes of different decisions, actions or events to converge at various points (Crawford 2012, ch. 8). Whilst branching narratives can have branch points dispersing in many different directions, and linear presentations would have events aligned in only one direction, foldback structures allow a certain amount of branching whilst bringing the points together periodically to events that are fundamental to the progression of the game and story. From a design perspective, this structure restricts combinatorial explosions by directing branches away from continuously subdividing the plot, thus reducing the workload in the design process. From a commercial perspective, this also eliminates the need for creating assets for digital games associated with multiple endings or events, which reduces the associated costs. Crawford (2012, ch. 8) dislikes foldback structures as they do not appear to permit any interactions that have consequences beyond the inevitable events they precede. Nevertheless, folding back upon events at various points in their stories is necessary in order to progress through games such as Mass Effect and Heavy Rain; which still contain multiple endings and reflect the consequences of their players’ actions at various levels of abstraction throughout.

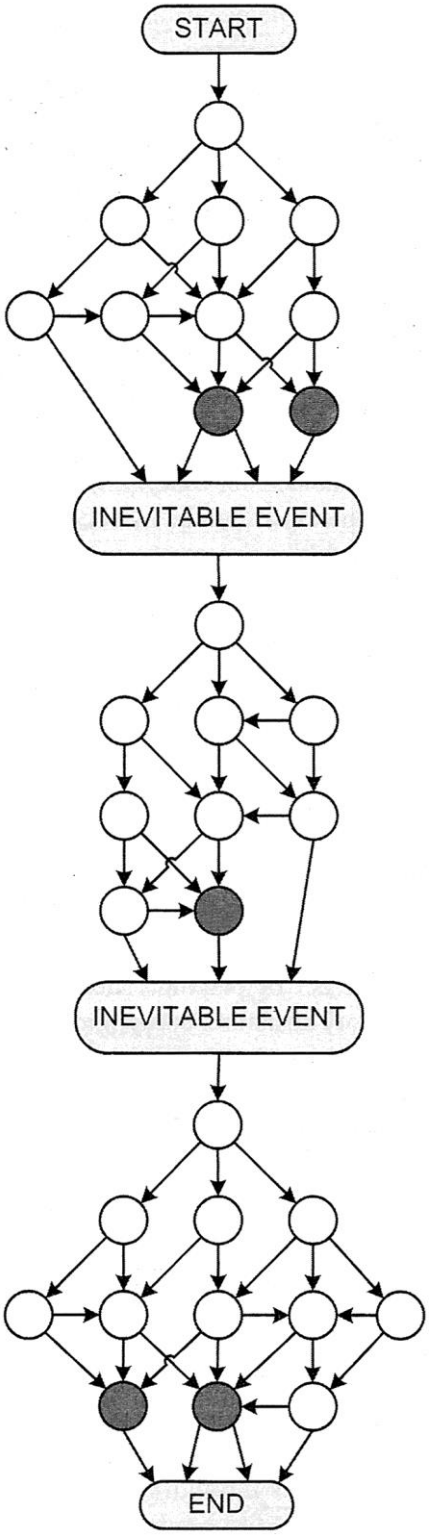


Figure 2.3.3.1 - Simplified structure of a 'foldback' story – the circles represent branch points, whilst dark spots represent branch points that always lead to an 'inevitable event' (Adams and Rollings 2007, p. 201)

Crawford (2012, ch. 8) uses the term ‘state variables’ to discuss the kinds of alterations that can result in different narratives even when branches fold back into inevitable events. In Mass Effect and Heavy Rain, for instance, players can still progress through the games’ stories even when main characters change or die as a consequence of the player’s actions. These characters are therefore variable within foldback structures. Crawford (2012, ch. 8) states that a randomised aspect to variables would be beneficial to interactive storytelling, which would equate to emergent narratives discussed by Adams and Rollings (2007). However, many games such as Mass Effect and Heavy Rain employ variables as part of their predetermined branching content; allowing narratives to fold back whilst storing these variables within a range of abstraction levels. The variable characters within Mass Effect and Heavy Rain would therefore be assigned to appropriate levels of abstraction in the design phase of the story in order to ensure that the player is still able to fold back to inevitable events and create a coherent narrative.

Figure 2.3.3.2 shows how such a structure might be represented, and how each branch point could correspond with different levels of abstraction. In Figure 2.3.3.1, the dark spots represent branch points that will always lead to an inevitable event. In Figure 2.3.3.2, the dark spots associated with the first level of abstraction will always either lead away from or into an inevitable event. The abstract nature of these branch points means that they are able to lead into more specific narrative elements at lower levels of abstraction. In order to contain the possible branches, the game reaches an inevitable event, where the previous actions of the player may or may not be stored as variables for subsequent events. In this respect, the foldback approach can be combined with abstraction levels to integrate considerations for the temporal, sequential and consequential elements of interactive stories. It can also be used to accommodate the hierarchy of important information within interactive stories; providing fundamental but

abstract narrative information adjacent to inevitable events, and more specific but less important narrative information at lower levels of abstraction.

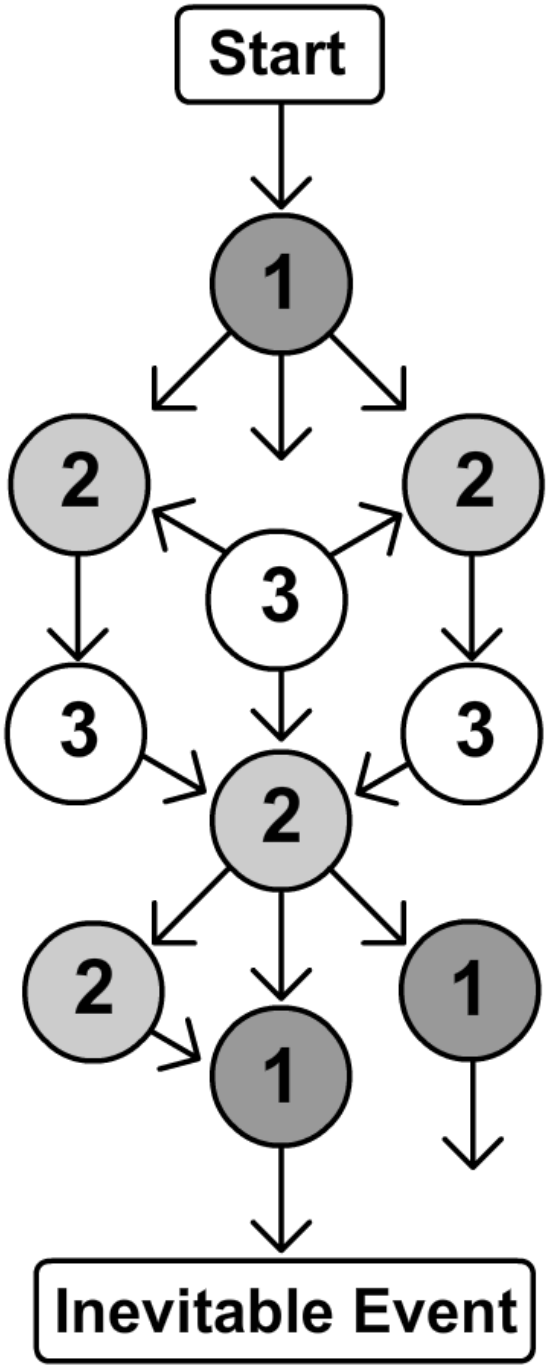


Figure 2.3.3.2 - A simplified adaptation of Adams' and Rollings' (2007, ch. 7) foldback structure to accommodate Aylett et al.'s (2008a, 2008b) abstraction levels

The foldback model complements abstraction levels with additional details in the form of branch points and the sequential realisations of narratives within stories. Variables, such as the disposable characters in the games Mass Effect and Heavy Rain, can be combined with foldback structures and levels of abstraction in design processes to determine the impact of certain events. Breaking down the units of an interactive story into branch points, inevitable events, levels of abstraction and variables serves to demonstrate the designer's role in determining how abstract the different parts of the story are, what information is contained within the branch points, and the impact these branches will have. The optional deaths of characters in Mass Effect and Heavy Rain, for instance, may seem to be a severe method of changing the course of a narrative in an interactive story, but ultimately the impact of such events depends upon the level of abstraction to which they are assigned. In these games, the deaths of characters can have a profound impact, but the story can still be completed at a higher level of abstraction.

2.3.4 – Dialogue Trees

Foldback structures, variables and abstraction levels, in addition to providing designers with tools to develop interactive story content, can help assign the functions through which this content can be delivered. As stated in Section 2.3.2, the complexities of digital media allow for narrative information to be delivered to, and manipulated by, users in a variety of ways in interactive stories. In the context of this thesis, and explorations into the design and visualisation of interactive stories, it is worthwhile exploring dialogue trees as they are one of the more common methods for exploring and delivering content in story-driven games (Rouse III, 2005; Adams and Rollings, 2007; Crawford, 2012). In addition, dialogue trees are visually representative of the structures and hierarchies described above, and can therefore be employed to both visualise the designs and specify the content of interactive stories.

In Mateas' (2001) Neo-Aristotelian approach to interactive storytelling as discussed in Section 2.2.2, narrative information is contained within 'materials' with which the user interacts, which can include the dialogue of other characters and the interface through which users interact with them. In the interactive drama Façade, the user can interact with these materials by controlling their character's conversations using natural language typed on a keyboard (Mateas and Stern, 2003). In digital games, however, Rouse III (2005), Adams and Rollings (2007, ch. 7) and Crawford (2012) note that conversations between player character(s) and non-player characters tend to be controlled by selecting dialogue options from lists of possibilities, examples of which can be seen in the top images of Figures 2.3.2.2 and 2.3.2.3 in the games Mass Effect and Heavy Rain. The responses non-player characters give to these options can result in more options that create dialogue trees, a representation of which can be seen in Figure 2.3.4.1. Dialogue trees therefore provide a method for delivering and interacting with stories that can also be employed to design and visualise story content.

Though dialogue trees can result in combinatorial explosions to the same extent as branching narratives, they can also employ foldback structures to avoid this problem. Figure 2.3.4.2 shows how dialogue within folding structures could also correspond with different levels of abstraction. Whilst each dialogue choice and response could progress to a different abstraction level, the diagram shows that it would be possible for the story to loop back upon itself, depending upon the level of information obtained. In this example, the user should be encouraged to progress to the first section (a) of required information (level 1), but there are a number of different options that can be explored prior to this, which could affect the information gained, the narratives experienced, and the variables altered by the user.

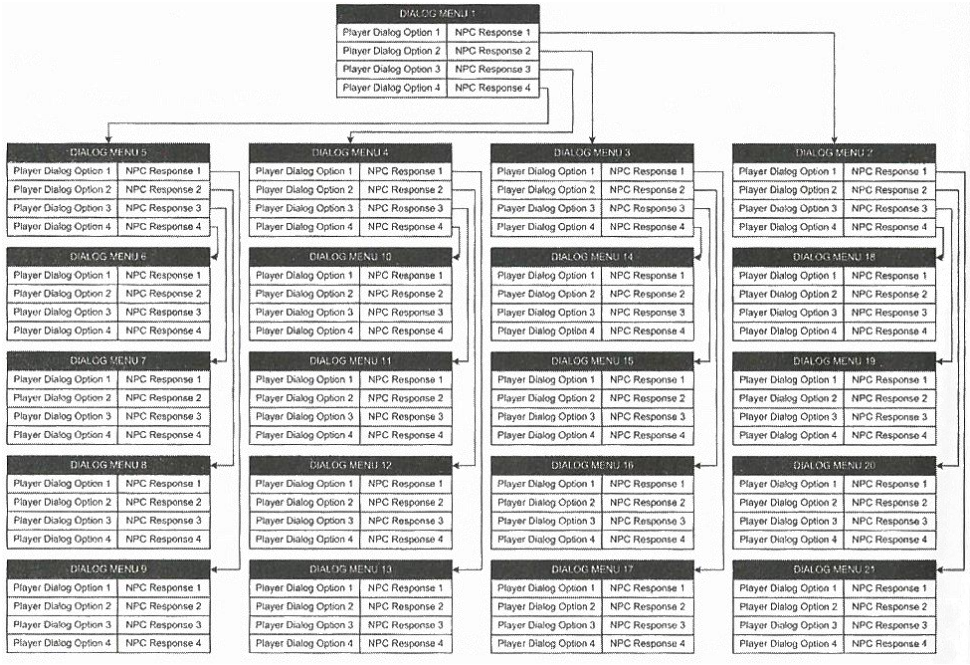


Figure 2.3.4.1 - A simple diagram of a dialogue tree (Adams and Rollings 2007, p. 212)

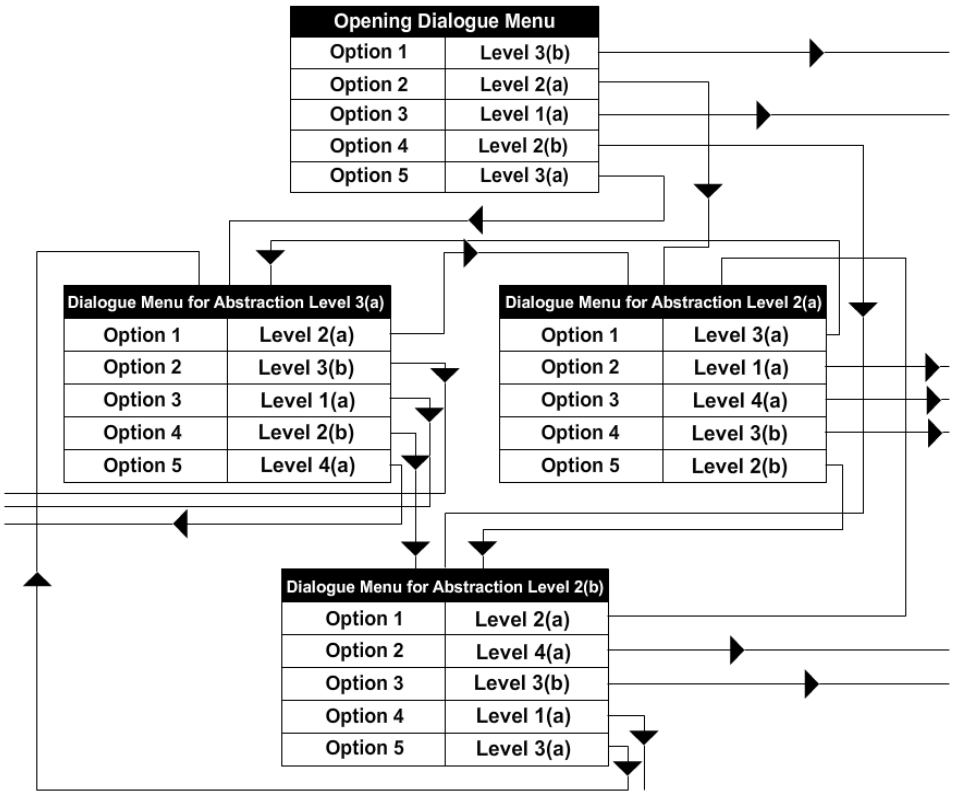


Figure 2.3.4.2 - An adaptation of a dialogue tree to incorporate Aylett et al.'s (2008a, 2008b) abstraction levels

These diagrams demonstrate how dialogue trees can represent the designs and content of stories; creating patterns that show the extent to which different selections can impact narratives. As stated above, dialogue trees are just one method of delivering story content, and dialogue would be a specific 'material' in the context of interactive stories. Many digital games employ many different types of materials to deliver story content, and dialogue trees could be nested within complicated hierarchies of story content. It is therefore appropriate to explore additional hierarchies of story content that could be combined with those explored so far in this chapter. Story grammars and schemata are examples of such representations, and could be employed to visualise the material structures and content hierarchies of interactive stories.

2.4 – Story Grammars and Schemata

Theories of story grammars and schemata were developed in the 1970s and 1980s to explore how humans comprehend stories, and how this understanding could be used to inform approaches to artificial intelligence (Ryan, 2008b; Stein and Kissel, 2008; Schank, 1995). Story grammars are derived from theories of linguistics, and suggest that grammatical structures could be used to understand the content and reception of stories, in the same way that they help understand how humans are able to comprehend language and communicate with one another (Chomsky, 1969; Thorndyke, 1977; Rumelhart, 1975). There are a number of different approaches to story grammars, with proponents creating structures of varying complexity to accommodate simple stories. As this thesis is concerned with the assistance such structures could provide designers rather than their suitability for studying comprehension, a full discussion of the possible grammars that could be employed will not discussed. However, as all representations of story grammars incorporate hierarchical tree structures, they could all be incorporated within the representations of interactive stories explored so far.

2.4.1 – Grammar Rules for Simple Stories

Thorndyke's (1977) grammar rules for simple stories are a noteworthy example of story grammars, and are displayed in Table 2.4.1.1. Though presented as a table, it is apparent that the rules are hierarchical, as elements within a story are contained within one another. According to rule number 1, A 'Story' contains a 'Setting', 'Theme', 'Plot' and 'Resolution'. A 'Setting', according to rule number 2, contains 'Characters', 'Location' and 'Time', which, in turn, contain their own 'States' according to rule number 10. A 'Plot' contains an 'Episode', which in turn contains a 'Subgoal', 'Attempt' and 'Outcome', and so on.

The definitions of these terms can vary depending upon the story grammar being employed. Mandler and Johnson (1977), for example, might state that an 'Episode' is contained within an 'Event Structure', rather than an 'Event' being contained within an 'Episode', as inferred by Thorndyke's (1977) rules. This is one of the identified problems of story grammars that have been raised by subsequent theorists. Although there is substantial empirical evidence to suggest that people bring structural assumptions with them to readings of stories (Stein, 1982), there is concern over the assumed validity of such structures, in part due to the inconsistencies of their applications and assumptions made over their definitions (Garnham, 1983; Black and Wilensky, 1979; Wilensky, 1983). The hierarchical tree structures of story grammars have also been challenged by less linear models that could better reflect the complexities of cognitive hierarchies, the different 'readings' people bring to stories, and the different aspects of stories to which they respond (Ryan, 2008b). However, when combined with the structures explored previously in this thesis in relation to interactive stories, story grammars could be employed within the processes of designing branching narratives of varying complexity.

Rule Number	Rule		
(1)	STORY	→	SETTING + THEME + PLOT + RESOLUTION
(2)	SETTING	→	CHARACTERS + LOCATION + TIME
(3)	THEME	→	(EVENT)* + GOAL
(4)	PLOT	→	EPISODE*
(5)	EPISODE	→	SUBGOAL + ATTEMPT* + OUTCOME
(6)	ATTEMPT	→	EVENT* / EPISODE
(7)	OUTCOME	→	EVENT* / STATE
(8)	RESOLUTION	→	EVENT / STATE
(9)	SUBGOAL / GOAL	→	DESIRED STATE
(10)	CHARACTERS / LOACTION / TIME	→	STATE

Table 2.4.1.1 - Thorndyke's (1977, p. 79) "Grammar Rules for Simple Stories" - parentheses indicate that the event is optional, and asterisks indicate that the element could be repeated

2.4.2 – Grammar Rules and Abstraction Levels

An example of how story grammars could be combined with approaches to interactive storytelling can be seen in Table 2.4.2.1, which shows how the hierarchy of Thorndyke's (1977) model could be arranged according to Aylett et al.'s (2008a, 2008b) abstraction levels. Apart from showing the elements that could be contained within each abstraction level, this also serves to visualise the hierarchical relationship between story materials. In a traditional, linear 'Story' (High Level), a 'Plot' (Level 2) consists of a series of 'Episodes', in which 'Characters' (level 3) will 'Attempt' to achieve 'Subgoals' (Level 4) which have 'Desired States' (Level 5) in pursuit of an overall 'Goal' (level 3). Following the layout depicted in Table 2.4.2.1, the author might have a general 'goal' in mind for the reader, which is abstract enough to accommodate a series of 'subgoals' that the reader could directly influence at lower levels of abstraction. For example, in the games Mass Effect and Heavy Rain described in Section 2.3.2, the survival of characters might be subgoals that the player would aspire to, but he or she could still finish the game's story if these were not explored or achieved. To deliver this, a character might have a conversation at a high level of abstraction that contains a dialogue tree such as those discussed in Section 2.3.4, which in turn provides access to a branching hierarchy at a lower level of abstraction. In such a scenario, the conversation between two characters could be an 'episode' at a higher level of abstraction than the 'outcome' of the dialogue explored. Designers of interactive stories could therefore employ this approach to determine the extent to which they intend the outcome of their users' actions to impact the narrative in pursuit of the overall 'goal' of the story.

<table>
<tr><th>ABSTRACTION</th><th colspan="6">STORY GRAMMAR RULES</th></tr>
<tr><td>HIGH LEVEL</td><td colspan="6">STORY</td></tr>
<tr><td>LEVEL 2</td><td>SETTING</td><td>THEME</td><td colspan="3">PLOT</td><td>RESOLUTION</td></tr>
<tr><td>LEVEL 3</td><td>CHARACTERS / LOCATION / TIME</td><td>(EVENT)* + GOAL</td><td colspan="3">EPISODE*</td><td rowspan="3">EVENT / STATE</td></tr>
<tr><td>LEVEL 4</td><td rowspan="2">STATE</td><td rowspan="2">DESIRED STATE</td><td>SUBGOAL</td><td>ATTEMPT*</td><td>OUTCOME</td></tr>
<tr><td>LOW LEVEL</td><td>DESIRED STATE</td><td>EVENT* / EPISODE</td><td>EVENT* / STATE</td></tr>
</table>

Table 2.4.2.1 - An example of mapping Thorndyke's (1977, p. 79) Grammar Rules against Aylett et al.'s (2008a, 2008b) Levels of Abstraction – parentheses indicate that the event is optional, and asterisks indicate that the element could be repeated

2.4.3 – Grammar Rules and Tree Structures

Figure 2.4.3.1 shows how such structures could be visualised in the form of tree diagrams. This is Rumelhart's (1975) representation of the syntax of an example of a short story, shown in Table 2.4.3.1. It is noteworthy in that it shows how the same element (in this case 'event') can be repeated within a hierarchical tree diagram to show the sequential and/or temporal nature of stories, which is not as easily achieved in the layout of abstractions. When combined with the studies of similar diagrams related to the design of stories in games, particularly those discussed in Section 2.3.3, it can be conceived that a representation of the syntax of a story could be incorporated with both abstraction levels and branching stories.

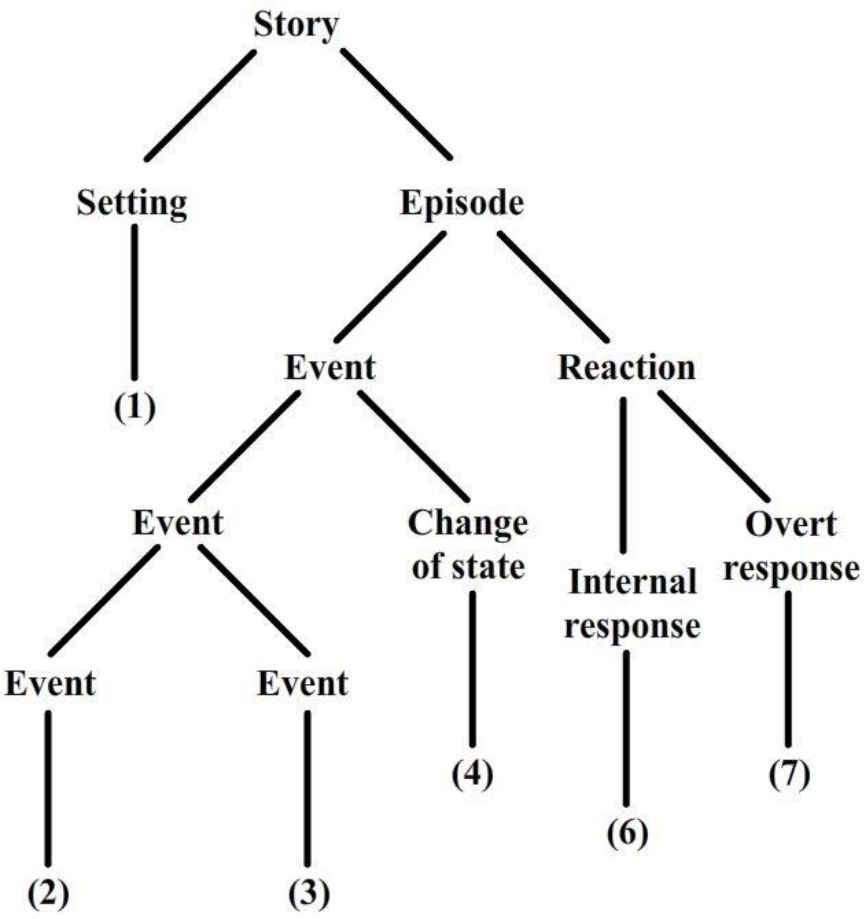


Figure 2.4.3.1 - "The syntactic structure of the [Margie] story" (Rumelhart 1975, p. 217)

UNITS	STORY
(1)	Margie was holding tightly to the string of her beautiful new balloon
(2)	Suddenly, a gust of wind caught it
(3)	and carried it into a tree.
(4)	It hit a branch
(5)	and burst.
(6)	[sadness]
(7)	Margie cried and cried.

Table 2.4.3.1 - "The units of the Margie story" (Rumelhart 1975, p. 216)

2.4.4 – Grammar Rules for an Interactive Story

Taking Rumelhart's "Margie" story as an example, the designer of an interactive story could begin by deciding upon the fundamental content, conceived as both abstract descriptions of the story and as a series of what Adams and Rollings (2007, ch. 7) might call 'inevitable events'. In the case of the Margie story, the existing hierarchy shows that the 'setting' and the 'episode' are at the highest points, with the 'episode' containing both 'event' and 'reaction' structures with their own hierarchies. Though absent from Rumelhart's rendering in Figure 2.4.3.1, the setting as described in Table 2.4.3.1 clearly contains specific information such as a 'character' and a 'state', which could be rendered within its own hierarchy according to other grammars, including Thorndyke's (1977). This may or may not be essential information depending upon the requirements of the designer. In this case, the assumption will be made that it is essential, as it contains information pertaining to the 'reaction'.

Within the ‘reaction’ we see Margie’s internal and overt response, which can correspond with both an abstract description and an inevitable event respectively. The preceding event structure is therefore where the events that led to this reaction are contained. This can be summarised by stating that the cause of Margie being sad and crying was that she lost her balloon; which is sufficiently abstract to accommodate the specific events that caused this to happen. Table 2.4.4.1 shows how this event structure could be adapted into an interactive story containing different possible branches detailing how the balloon was lost. The table shows the existing syntax being mapped against levels of abstraction, with more specific details of the balloon’s fate being contained at the lowest level. The different possible descriptions for the balloon being lost are also shown as parallel syntaxes contained within the same event structures, with “Margie lost her balloon” at the top of the hierarchy. It should be noted that, in this case, the beginning and the end of the story are displayed as traversing all the levels of abstraction. This is because they could be deemed to be fundamental to the story and therefore do not require assignment to specific levels of abstraction from the designer’s perspective. It should also be stated that, in this case, the length of the table represents the sequence of the narrative, rather than the different elements that can be contained within a story, as shown in Table 2.4.2.1. Although this may naturally occur within the syntax of short stories, it is coincidental that, apart from the ‘reaction’ hierarchy, the numbers in the sequence of narrative units correspond with the levels of abstraction within the table.

<table>
<tr><th>ABSTRACTION</th><th colspan="9">STORY</th></tr>
<tr><td>HIGH LEVEL</td><td rowspan="5">(1) Margie was holding tightly to the string of her beautif-ul new balloon</td><td colspan="7">(2-5) Margie lost her balloon</td><td rowspan="5">(6-7) Margie was sad and cried and cried</td></tr>
<tr><td>LEVEL 2</td><td colspan="3">(2) Suddenly, a gust of wind caught it</td><td colspan="4">(2) Suddenly, someone grabbed it from her</td></tr>
<tr><td>LEVEL 3</td><td colspan="2">(3) And carried it into a tree</td><td colspan="2">(3) And carried it up into the sky</td><td colspan="2">(3) And gave it to another child</td><td colspan="2">(3) And ran away with it</td></tr>
<tr><td>LEVEL 4</td><td colspan="2">(4) It hit a branch</td><td colspan="2">(4) It got smaller and smaller</td><td colspan="2">(4) The child carried it away</td><td colspan="2">(4) It got smaller and smaller</td></tr>
<tr><td>LOW LEVEL</td><td>(5) And burst</td><td>(5) And got stuck</td><td>(5) Until it burst</td><td>(5) Until it disappeared</td><td>(5) and laughed</td><td>(5) and burst it</td><td>(5) Until it burst</td><td>(5) Until it disappeared</td></tr>
</table>

Table 2.4.4.1 - Adaptation of Rumelhart's (1975) "Margie" example into a branching story mapped against levels of abstraction

When translated back into a tree diagram, the relationship between these units in terms of sequence may be more apparent, at the cost of clarifying their corresponding levels of abstraction. Figure 2.4.4.1 shows how the branches could be related to a foldback structure as described in Section 2.3.3. This also demonstrates how some story units could be shared across different narratives, such as the balloon bursting. Once the branches have been crossed to the lowest level of abstraction, the story folds back into Margie becoming sad, and ultimately the 'inevitable event' of her crying.

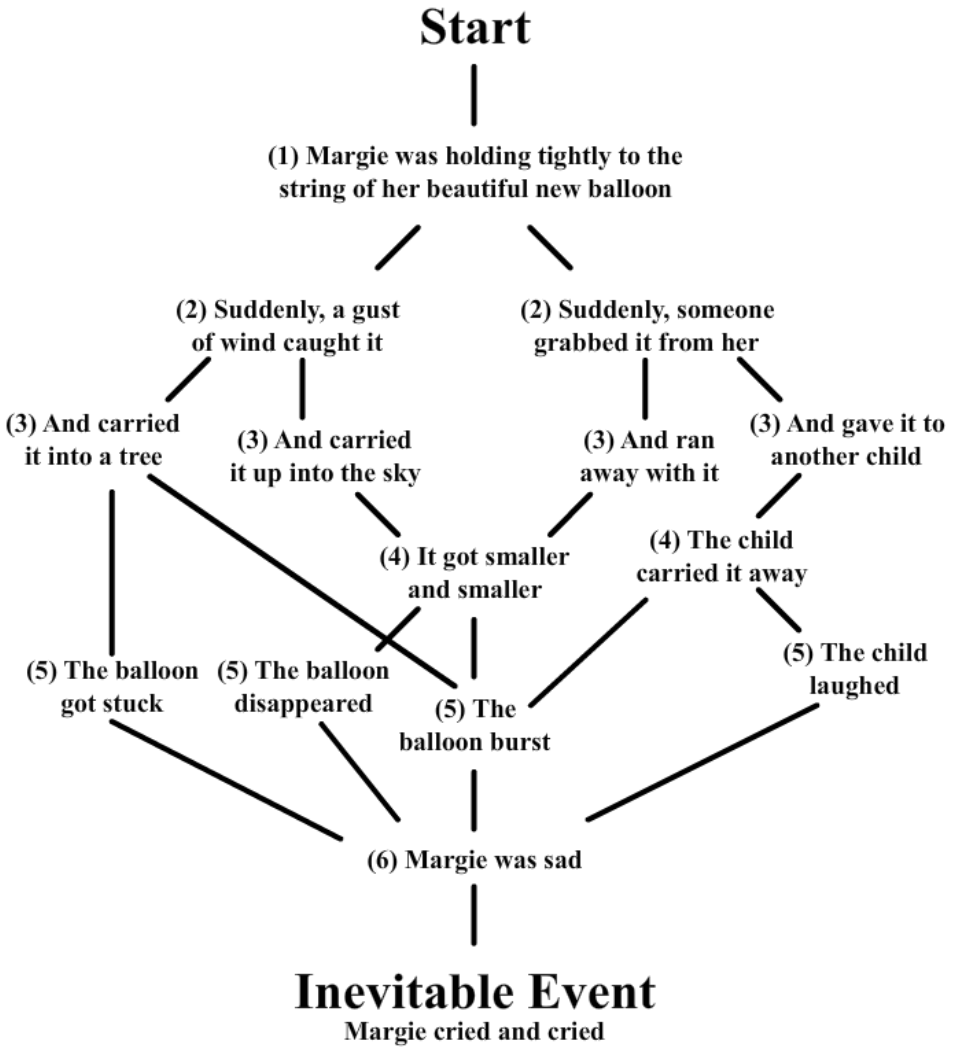


Figure 2.4.4.1 - A branching version of Rumelhart's (1975) example of a short story mapped against a foldback structure

It is acknowledged that the story employed as an example in this brief exploration of grammar rules for an interactive story is extremely simple. The integration of changing variables at different levels of abstraction, for instance, would have next to no impact within such a short sequence. Nevertheless, it can be conceived how such variables could be integrated in longer stories. Whether the balloon was stolen or a gust of wind took it, for example, might have a profound effect upon Margie, even if the event of her crying is inevitable. This could be correlated with subsequent events at equivalent levels of abstraction, whilst still permitting the story to continue uninterrupted at its highest level.

2.5 – Conclusion

Approaches to stories and interactive stories have involved considerations for the roles of authors and readers or creators and users to various extents. This is a fundamental dilemma identified in theories of interactive story designs, and balancing the freedoms afforded users with the creative and commercial considerations of creators and the technical possibilities of systems has been approached in various ways. Throughout the present chapter, hierarchical structures based upon levels of abstraction have emerged as being consistent with the requirements of interactive story designs. The similarities between the different structures explored have enabled the development of diagrammatic representations depicting the different functions, content and variables that could be changed in interactive stories, and the impact these changes could have at different levels of abstraction. Examples of digital games show that current implementations of variables and foldback structures can be used to avoid combinatorial explosions within designs, allowing players to explore different possibilities within story content whilst limiting pressures upon designers and producers.

However, the visualisations of these structures serve to show that ambiguity remains in design processes, and no single representation is sufficient to accommodate the complexities of interactive stories. The interactive version of the Margie story from Section 2.4.4, for example, is not adequately visualised by either Table 2.4.4.1 or Figure 2.4.4.1. Though the combination of these representations would be more suitable, additional information about the longer-term impact of variable changes would still be required. Chapter 3 will use this insight to compare the representations of interactive stories in this chapter to approaches to comics, and explore how comics can be used to visualise the benefits and counter the limitations of previous approaches to designing interactive stories.

CHAPTER 3: EMPLOYING COMICS TO DESIGN AND VISUALISE INTERACTIVE STORIES

3.1 – Introduction

This chapter presents the case for employing comics in the processes of designing and visualising interactive stories. This argument incorporates an overview of the theoretical and practical developments in comics mapped against the explorations of stories and interactive stories covered in Chapter 2. It is shown that comics serve to not only present stories but also visualise the hierarchies of narrative information within stories, and it is argued that this aspect can be used in the processes of designing content for interactive stories.

Examples of comics that can be related to these theories are also discussed, which have manipulated the layout of panels and 'strips' to portray multiple narrative threads. An alternative approach is then proposed wherein the contents of panels within comics, rather than their layouts, are embellished through interactions. It is argued that this approach is more appropriate for representing the theories covered in the thesis, and that the proposed process can also compensate for some of the potential problems of designing and visualising branching stories.

3.2 – Applying Theories of Comics to Interactive Stories

There are several theoretical approaches to comics that can be related to the theories of stories and interactive stories explored so far in the thesis. Aligning these theories provides evidence for the suitability of comics to be incorporated in the processes of designing interactive stories, as well as a theoretical foundation upon which to do so.

3.2.1 – Visual Levels of Abstraction

Research into comics is a growing area, and Scott McCloud's (1993) 'Understanding Comics' has been influential in recent studies (Cohn, 2010, 2012, 2014). A noteworthy concept of McCloud's in the context of this thesis is that of visual abstraction, which is illustrated in Figure 3.2.1.1. In this sequence, the image on the left most accurately resembles a human face. From left to right, the remaining images become increasingly abstracted, stylised and simplified. McCloud (1993) argues that the visual abstraction of people and things in comics contributes to the definition of 'cartoons', and facilitates identification with characters by readers. This is because, as both McCloud (1993) and Cohn (2012) demonstrate following other explorations of visual structures, the simplification of representations encourages readers of comics to infer details that could be added or may be missing in drawings. For example, in the most abstract rendering of the face in Figure 3.2.1.1, it is anticipated that the viewer will identify that this is a representation of a face even though prominent details such as the nose and ears are missing. McCloud's view is that the additional details readers assign are more reflective of their personal experiences, and therefore that cartoons encourage readers to engage with their representations. Although there is currently little evidence available to support this theory, it is similar to other theories of the cognitive models readers use when comprehending stories, which will be discussed in Section 3.2.2.

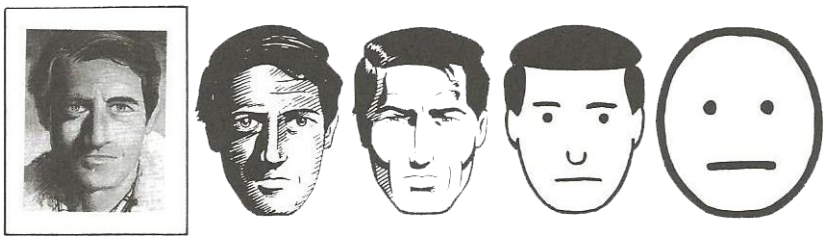


Figure 3.2.1.1 - McCloud's (1993, p. 31) visual abstraction of a face

Aside from their application to theories of story comprehension, such abstractions can be adapted for the purposes of designing and visualising interactive stories. McCloud's (1993) visual abstractions could correspond with the abstractions of story content as discussed in Chapter 2, for instance. Table 3.2.1.1 demonstrates how McCloud's renderings of a face could correspond with the levels of abstraction and story grammars as represented in Table 2.4.2.1. In Table 3.2.1.1, the faces are simply assigned to the different levels of abstraction, which is not necessarily indicative of the visual representations that could be provided at various abstractions. Nevertheless, assigning visual abstractions to different abstraction levels of story content could facilitate the processes of designing and visualising interactive stories. Taking McCloud's abstraction of a face as an example, the designer may simply require a 'character' in their interactive story at a high level of abstraction. At lower levels of abstraction the user would have more control over the character's representation, which may impact events at lower levels of abstraction but would have limited impact upon the overall progression of the story. Following discussions of digital games in the Chapter 2, it is worth noting that this example reflects many existing role-playing games such as Mass Effect (2009); wherein the player is invited to modify the physical attributes of their virtual character(s), such as gender, ethnicity and clothing, at the beginning of the game. Such alterations could impact games in various ways, such as the abilities of characters and the relationships with non-player characters that could be formed. Integrating visual abstractions within interactive story designs could therefore be used to determine these variables visually, as well as their impact upon the story at different levels of abstraction.

<table>
<tr><th colspan="2">ABSTRACTION</th><th colspan="6">CONTENT</th></tr>
<tr><td>HIGH
LEVEL</td><td>  </td><td colspan="6">STORY</td></tr>
<tr><td>LEVEL 2</td><td>  </td><td>SETTING</td><td>THEME</td><td colspan="3">PLOT</td><td>RESOLUTION</td></tr>
<tr><td>LEVEL 3</td><td>  </td><td>CHARACTERS /
LOCATION / TIME</td><td>(EVENT)*
+ GOAL</td><td colspan="3">EPISODE*</td><td rowspan="3">EVENT /
STATE</td></tr>
<tr><td>LEVEL 4</td><td>  </td><td rowspan="2">STATE</td><td rowspan="2">DESIRED
STATE</td><td>SUBGOAL</td><td>ATTEMPT*</td><td>OUTCOME</td></tr>
<tr><td>LOW
LEVEL</td><td>  </td><td>DESIRED
STATE</td><td>EVENT* /
EPISODE</td><td>EVENT* /
STATE</td></tr>
</table>

Table 3.2.1.1 - Mapping Aylett et al.'s (2008a, 2008b) concept of abstraction levels against McCloud's (1993, p. 31) visual abstractions of a face and Thorndyke's (1977) story grammar rules

3.2.2 – Levels of Abstraction in Visual Stories

In addition to a theory of visual abstraction, McCloud (1993) has explored the narrative qualities of comics specifically, which can also be related to notions of abstraction. As stated in Chapter 1, comics employ sequences of panels to convey a story. In the same way that readers can infer details from abstract visual representations, McCloud also argues that readers infer narrative information within the spaces between panels of a comic, also known as 'gutters'. Whilst the passing of time can be inferred within single panels depending upon their contents, McCloud argues that by fracturing images into sequences, gutters create temporal, spatial and thematic links between panels that readers associate with one another in comics. Whilst films and television present images to audiences fast enough for them to bridge their sequences unconsciously, comics' artists can employ the strategic positioning of gutters between visual information to encourage audiences to bridge the narrative information in various ways (McCloud, 1993).

McCloud (1993) uses a comic depicting a story with different numbers of panels to demonstrate the different ways in which readers could be encouraged to make such inferences. Figure 3.2.2.1 shows this comic at its most detailed; presenting the story of a man who perishes after going out one night in his car in anticipation of a date with his girlfriend. The man's plans change after he realises his girlfriend is not available, so he ends up renting a video, buying some drinks, and crashing his car after drinking a beer whilst driving. Additional details are provided through the sequence of panels, indicating the passage of time and the different events that occurred, such as an extended sequence portraying the car being started and a conversation with a clerk at the video shop.

Figure 3.2.2.1 - McCloud's (1993, p. 84) example of a comic in a sequence of 52 panels

Having presented this version of the comic, McCloud subsequently reduces the number of panels within this sequence to demonstrate that it should still possible for readers to create coherent narratives with less information. Figure 3.2.2.2 shows one version of the comic that omits certain details, such as the man trying to find his car keys, starting his car, and his trip to the video shop. The version of the comic in Figure 3.2.2.3 portrays the man driving his car whilst drinking having promised he won't drink and drive in the opening panel, followed by the car crashing in the penultimate panel and finally his death inferred by the picture of the gravestone. The least detailed version of the comic in Figure 3.2.2.4 simply contains the opening and closing panels of the story, encouraging readers to infer that the man died as a result of his failure to keep his promise to not drink and drive.

The cognitive functions required to make sense of limited narrative information have been identified as 'situation models' (van Dijk and Kintsch, 1983) or 'mental models' (Black et al., 1986; Johnson-Laird et al., 1992) in the context of studies of story comprehension, in which it has been argued that readers use background knowledge to create plausible inferences during the comprehension of texts and story fragments. In comics, such fragmentation is visualised by the separation of panels by gutters. McCloud (1993, p. 63) defines the inferences readers make during the gutters between panels as 'closure', and argues that readers would not be able to comprehend comics if closure did not take place. In the examples above, the different amounts of closure required is proportional to the number of panels of visual narrative information provided in the story, and it is anticipated that readers will make inferences in accordance with their mental or situation models of what is plausible and probable in the context of the adjoining panels. In this respect, the story presented becomes increasingly abstract, and the possibilities of what occurs between panels are increased, as fewer panels are provided.

Figure 3.2.2.2 - McCloud's (1993, p. 85) example of a comic in a sequence of 10 panels

Figure 3.2.2.3 - McCloud's (1993, p. 85) example of a comic in a sequence of 4 panels

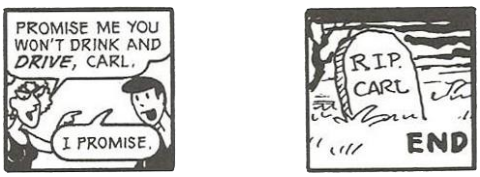


Figure 3.2.2.4 - McCloud's (1993, p. 85) example of a comic in a sequence of 2 panels

The creation of narrative information between panels of comics by readers can therefore relate to the interpretations of abstract visual information within panels as discussed in Section 3.2.1, and could also be aligned with levels of abstraction. Table 3.2.2.1 shows how McCloud's (1993, p. 85) use of varying numbers of panels in a story could correspond to different levels of abstraction (Aylett et al., 2008a, 2008b; Crawford, 2012) in interactive stories. At the high level, the inevitable events (Adams and Rollings, 2007) at the beginning and at the end define the framework within which designers can construct interactive content in accordance with the

anticipated models (van Dijk and Kintsch, 1983; Black et al., 1986; Johnson-Laird et al., 1992) or closure (McCloud, 1993) of their users. In this case, as it is plausible and probable that the man in the story would have died in a car crash as a result of drinking and driving, it would be reasonable to create content that relates to this outcome at lower levels of abstraction. This can be seen at a medium level of abstraction, wherein it is specified that the man was drinking whilst driving in the second panel, which led to him crashing his car. At a lower level of abstraction, examples of additional events that users could explore are realised in panels depicting the man visiting his girlfriend's house and choosing to buy some beers. At even lower levels, additional details could be incorporated into the narrative as depicted in Figure 3.2.2.1.

Assigning McCloud's (1993, p. 85) comics to levels of abstraction illustrates the potential for comics to visualise hierarchies within stories, which can in turn be applied to designing interactive stories. As comics combine both images and text within sequences of panels to convey stories, both the visual and narrative content of comics can be employed to convey hierarchies of abstraction. For example, the visual abstractions depicted in Table 3.2.1.1 could be combined with the story abstractions depicted in Table 3.2.2.1 to convey a range of different variables that could be affected by users of interactive stories, such as the physical appearance of the protagonist. Although McCloud (1993) does discuss the structure of visual stories, hierarchical structures have also been discussed specifically in relation to comics in other works, which could be integrated within McCloud's approaches and those of stories and interactive stories discussed in the Chapter 2.

ABSTRACTION	STORY VISUALISATION
HIGH LEVEL	 
MEDIUM LEVEL	   
LOWER LEVEL	

Table 3.2.2.1 - Mapping McCloud's (1993, p. 85) examples of comics with different numbers of panels against levels of abstraction (Aylett et al., 2008a, 2008b)

3.2.3 – Levels of Visual Narrative Structures

At the time of writing, much recent work into the hierarchical narrative structures of comics has been done by Neil Cohn and his colleagues (Cohn, 2010, 2012; Cohn et al., 2012; Cohn, 2013b). In the same way that theories of story grammars were influenced by studies of linguistics, such approaches to the narrative structures of comics have also adapted linguistic structures. Cohn (2012) argues that studies of comics should take into account the sequence of panels as a whole, which can be related to studies of language and grammar. Cohn uses "My roommate, who is a total bore, watches TV all day" (Cohn 2012, p. 107) as an example of a sentence that reflects the type of embedded clauses that could also be found in comics. In this sentence, the transition from 'my roommate' to 'who is a total bore' does not present the full meaning or context of information given, which can also be the case with individual panel transitions. Cohn (2012, 2013b) consequently proposes that the transitions of panels within comics should be understood as part of the hierarchy of a broader narrative 'arc'. For the purposes of representing this approach, Cohn categorises panels into five broad definitions of units in a sequence: Establisher, Initial, Prolongation, Peak and Release. The definitions of these categories can be seen in Table 3.2.3.1, which are themselves derived from other approaches to story structures. The 'Establisher' for example, is reminiscent of the 'Setting', and the 'Release' could be compared to a 'Resolution' from theories of story grammars as discussed previously. Though not all strips contain all categories, Cohn argues that these categories form a syntax that can be used to analyse the content of comics.

Panel		Definition
Establisher (E)	→	Sets up an interaction without acting upon it
Initial (I)	→	Initiates the tension of the narrative arc
Prolongation (L)	→	Marks a medial state of extension, often the trajectory of a path
Peak (P)	→	Marks the height of narrative tension and point of maximal event structure
Release (R)	→	Releases the tension of the interaction

Table 3.2.3.1 - Cohn's (2013b, p. 425) definitions of panel categories

Once the categories of panels have been defined, Cohn (2013b) goes on to demonstrate that, though sequences of panels may be self-contained within short strips, they could also combine to form 'phases' within the arcs of stories. Figure 3.2.3.1, for example, shows how categories can alternate and then be embedded within a broader hierarchy. In this example, the 'Initial' phase is extended by embedding two adjacent phases within it, each of which have concluding 'Peak' panels. In Figure 3.2.3.2 the hierarchy is more complicated; and contains a series of Initial panels within an Initial phase, which is in turn embedded within a Peak phase of the arc. Such categorisation of panels could result in the same kinds of issues related to the categorisation of elements within story grammars discussed in the previous chapter. For example, the embedding or conjoining of phases within a story's arc may permit the categories of panels to be liberally altered, which could create inconsistencies in their definitions and therefore challenge the existence of such categories. Nevertheless, in the context of discussing the designs of interactive stories, Cohn's (2013b) approach could be aligned with previous explorations to facilitate the visualisation of hierarchies of story content.

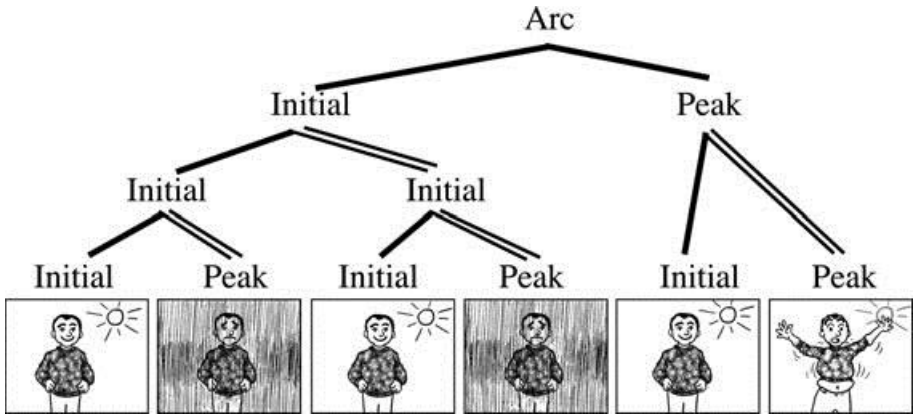


Figure 3.2.3.1 - Cohn's (2013b, p. 429) examples of alternating categories of panels within the hierarchy of a narrative arc

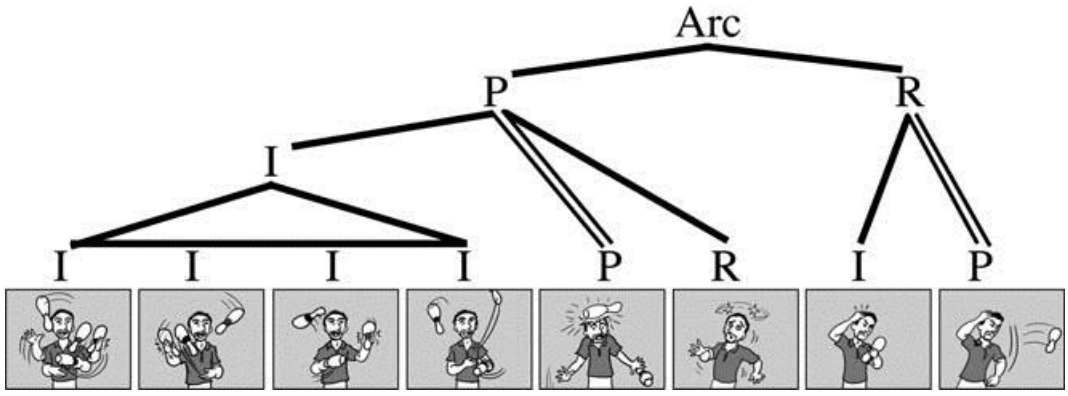


Figure 3.2.3.2 - Cohn's (2013b, p. 426) examples of embedded and conjoined phases within the hierarchy of a narrative arc

Table 3.2.3.2, for example, shows how Cohn's (2013b) visual narrative structure could be aligned with Aylett et al.'s (2008a, 2008b) levels of abstraction and McCloud's (1993, p. 85) comics. In addition to the representation of McCloud's deletions of panels against levels of abstraction, this table is designed to illustrate the structural modifications to the story that could result in the addition of panels within a hierarchy. With only two panels at the highest levels of abstraction, McCloud's comic would consist of an Initial and Peak panel, which Cohn (2013b)

argues are the most important categories. The addition of panels at the medium level of abstraction, however, serves to convert the panels at the high level of abstraction into Establisher and Release panels, due to the addition of alternative Initial and Peak panels within the arc. At a lower level of abstraction, McCloud's panels could be interpreted as being a sequence of brief phases that are embedded within the broader categories above. Along with the established conventions of visualising narrative units as panels in comics, here it is also shown that the categorisation of panels and phases could be employed to visualise complicated hierarchies within stories, in addition to units of story content themselves.

Whether designers intend to employ established categories, such as those of story grammars, or emerging categories, such as those proposed by Cohn (2013b), the process of dividing stories into visual units, groups of units and hierarchies could be employed to categorise how users interact with sequences. It could be argued, for instance, that the top level of abstraction in Table 3.2.3.2 shows the grammar rules of Theme, Setting and Resolution being rendered within Initial and Peak panels, which the user would have no impact upon. At the medium level, a core Plot in which someone drinks whilst driving and crashes their car is portrayed through alternative Initial and Peak panels, which could be inevitable events in an interactive story. At lower levels of abstraction, the categorisation of panels into phases facilitates the visualisation of potential Episodes that could lead to this outcome, which the user could have greater freedoms exploring. Consequently, this hierarchical categorisation could also be employed to visualise the comic in interactive form specifically. This can be seen in Figure 3.2.3.3, which demonstrates how the categorisations of panels and phases in Table 3.2.3.2 could be adapted to foldback structures of interactive stories as discussed in the previous chapter.

<table>
<tr><th>ABSTRACTION</th><th colspan="7">VISUAL NARRATIVE STRUCTURE</th></tr>
<tr><td>HIGH
LEVEL</td><td colspan="7">INITIAL
 

PEAK
 
</td></tr>
<tr><td>MEDIUM
LEVEL</td><td colspan="2">ESTABLISHER
 
</td><td colspan="2">INITIAL
 
</td><td colspan="2">PEAK
 
</td><td colspan="2">RELEASE
 
</td></tr>
<tr><td>LOWER
LEVEL</td><td>EST.
 
</td><td>INITIAL
 
</td><td>PEAK
 
</td><td>INITIAL
 
</td><td>PEAK
 
</td><td>INITIAL
 
</td><td>PEAK
 
</td><td>INITIAL
 
</td><td>PEAK
 
</td><td>REL.
 
</td></tr>
</table>

Table 3.2.3.2 - Aligning Cohn's (2013b) Visual Narrative Structure with Aylett et al.'s (2008a, 2008b) levels of abstraction and McCloud's (1993, p. 85) examples of comics

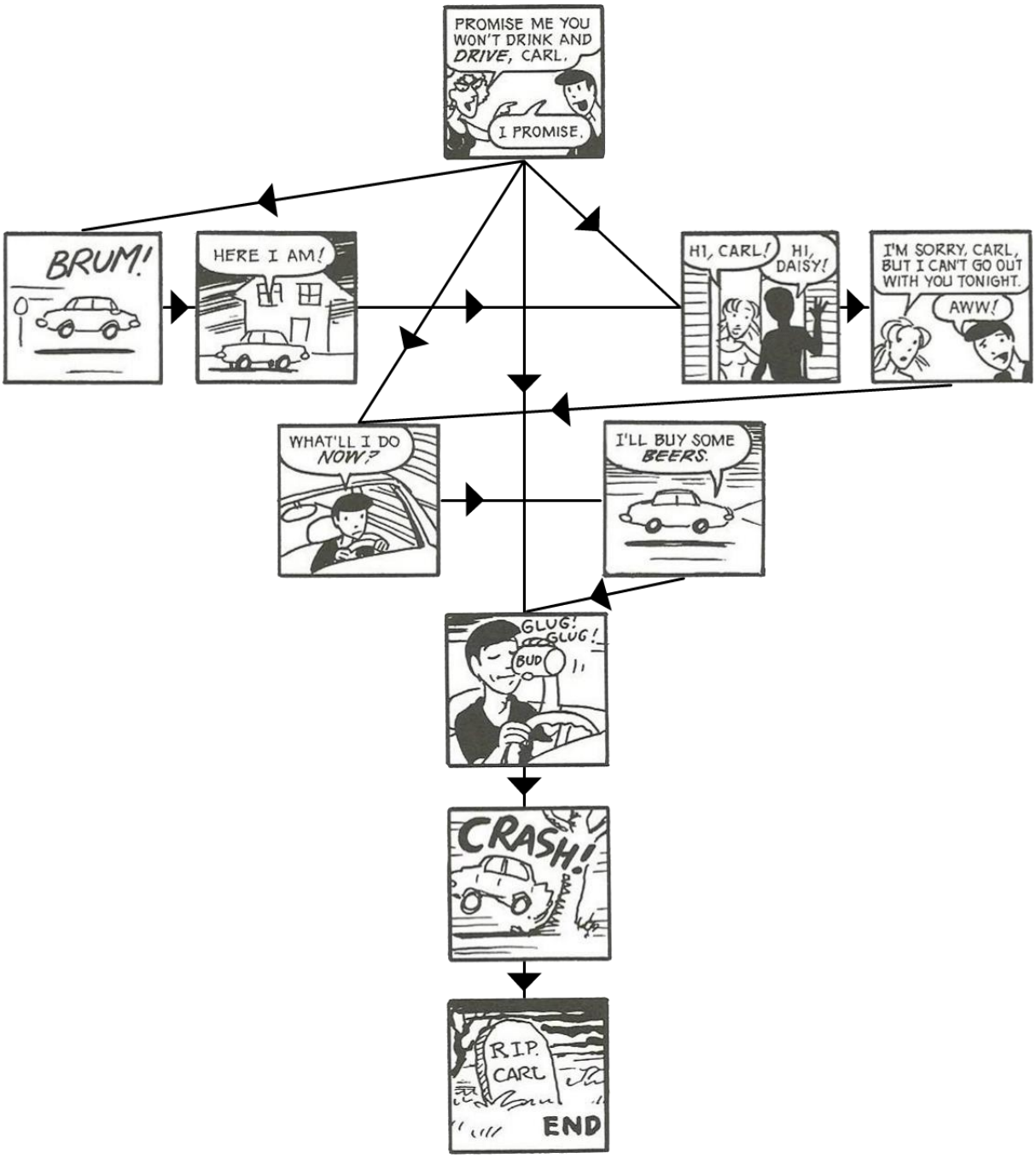


Figure 3.2.3.3 - Representing McCloud's (1993, p. 85) comic according to Adams' and Rollings' (2007) foldback structure for the purposes of designing an interactive story

Following McCloud's (1993, p. 85) selection of fundamental panels and the allocation of the deleted panels to phases, the separation of optional and inevitable sequences can be quickly realised. In some cases, the categorisation of panels or phases may not be consistent with other designs or readings. The second panel of the Lower Level of abstraction in Table 3.2.3.2, for instance, could be defined as a Prolongation panel within a phase according to Cohn's (2013b) categories (Table 3.2.3.1), as it depicts the state of extension of a car's journey. In such cases, designers of interactive stories would take into account the surrounding story and consider assigning these phases to other levels of abstraction. In Figure 3.2.3.3, for instance, the journey to the house in the car is portrayed as being entirely optional in an interactive story. This phase inevitably leads into the meeting at the house, but the user could also go straight to the house from the first panel, or miss the meeting altogether. The journey to the house could therefore be assigned to a lower level of abstraction, reflecting its potential to be categorised as a Prolongation phase. Ultimately, the assignment of panels to categories would depend upon the requirements of designers balanced with the anticipation and/or study of users' responses to interactive stories.

3.3 – Approaches to Non-linear Comics

The discussions in Section 3.2 demonstrate how certain theoretical approaches to comics can be aligned with theories of interactive stories covered in the Chapter 2. The current section explores previous approaches to creating branching comics that complement this theoretical foundation. Though panels can be ordered in the same way as text is in literature, authors of comics tend to exploit the size and arrangement of panels to deliver various reading experiences (McCloud, 1993; Eisner, 2008a; Cohn, 2013a). This has resulted in less linear depictions of stories that can have preferred readings or ambiguous renditions that encourage readers to

explore the panels rather than read them in a specific order. Though not all of these comics could be categorised as interactive stories according to the definitions provided in Chapter 1, they all provide further evidence for the suitability of employing comics in interactive story design processes.

3.3.1 – Parallel Narratives

In Figures 3.3.1.1 & 3.3.1.2, Eisner (2008a) demonstrates how panels can be arranged to depict parallel narratives, thus encouraging a non-linear reading experience. In this case, the comic presents an amusing story by depicting two narratives with striking similarities: one of a man incarcerated in a jail, and the other of his doppelganger imprisoned within an equally oppressive marriage. The joke is realised by showing similarities between the characters, dialogue, events and setting, accentuated by the drawings of two pages side by side with similar layouts of panels contained within. The story is clearly divided into two narratives that at an abstract level are closely linked (a man imprisoned with an aggressor, portrayed in a specific layout of panels) but at lower levels of abstraction the subtle differences emerge through the drawings. Indeed, if the drawings were less detailed following McCloud's (1993) abstraction discussed in Section 3.2.1 then they could appear to be depicting identical narratives. The comic therefore demonstrates one potential application of visualising levels of abstraction in comics, which could be applied to interactive story designs. For example, the layout of panels and abstract renditions could depict the designed requirements of the story at a high level of abstraction, whilst variables, such as the designs of characters, objects and settings, could emerge through the interactions of users at lower levels.

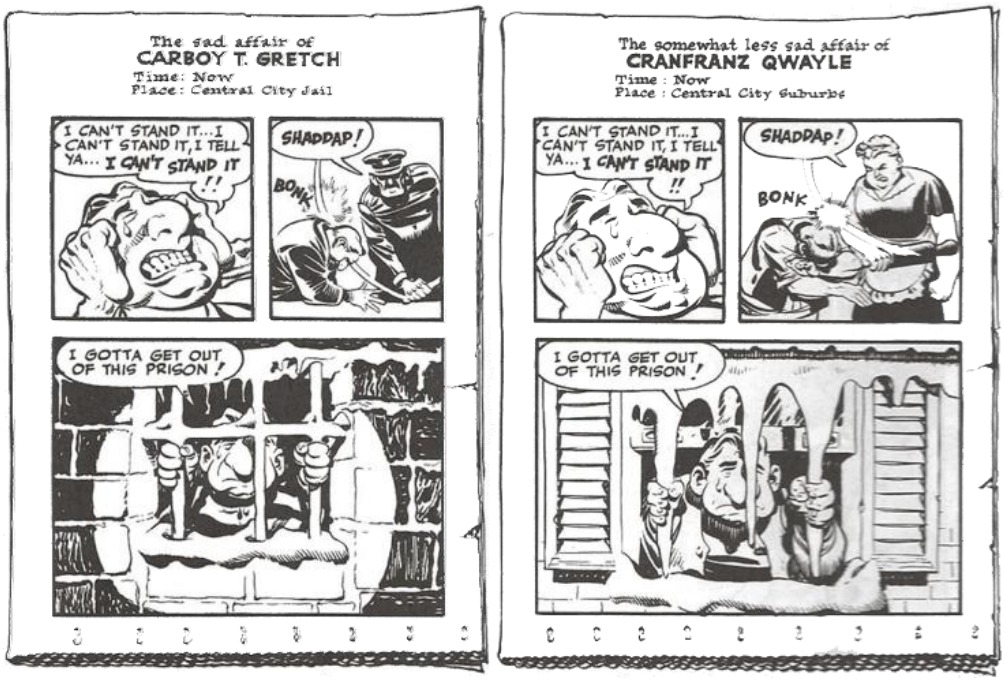


Figure 3.3.1.1 - Parallel narratives in comic form (Eisner 2008a, p. 83)

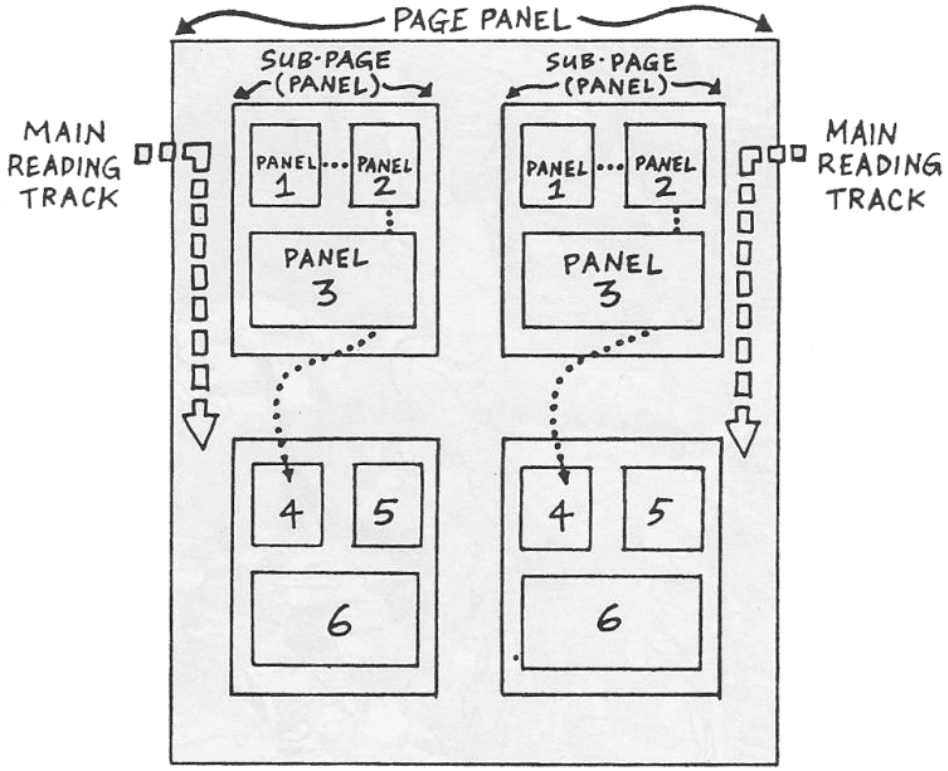


Figure 3.3.1.2 - How panels in parallel narratives can be 'read' (Eisner 2008a, p. 82)

3.3.2 – Branching Narratives

In an alternative approach, Figure 3.3.2.1 depicts a comic by McCloud (1993, p. 105) in which he demonstrates how panels can be arranged to depict branching narratives. This is a different presentation of McCloud's story described in Sections 3.2.2 and 3.2.3. In the previous comics, the death of the protagonist is inevitable, and the different numbers of panels in each comic could depict the different possibilities that occur prior to this event in an interactive story. In the example shown in Figure 3.3.2.1, however, the death of the protagonist is just one possibility amongst a number of endings. Taking English language conventions of reading left to right and top to bottom, the comic in Figure 3.3.2.1 begins in the upper-left corner, and continues right until the car crashes and the protagonist dies, just as he did in the previous comics. Yet the vertical strip of panels immediately below the second panel portray an important alternative choice: that the protagonist decided not to drink and drive, and therefore survived to make other decisions. Other branch points are visualised throughout the comic as panels that have different possible threads stream from them depending upon the direction in which the comic is read.

Some of the panels of McCloud's comic are shared between different threads, in the same way branch points can be shared in interactive stories designed through foldback structures, as discussed in Chapter 2. In some of these shared panels, McCloud exploits his own concept of closure as well as those of mental and situation models discussed in Section 3.2.2. For example, the identity of the silhouetted character, saying "What are *you* doing here?!" in a panel towards the bottom middle of the comic, depends upon the direction in which the adjacent panels are read. In the context of the sequence of panels read left to right, this character is the video store clerk, while if the comic is read top to bottom he is 'Mr. Gordon'. McCloud therefore demonstrates that that the ambiguity of visual imagery can be exploited to accommodate

multiple interpretations in branching stories, and exploit the mental or situation models of readers.

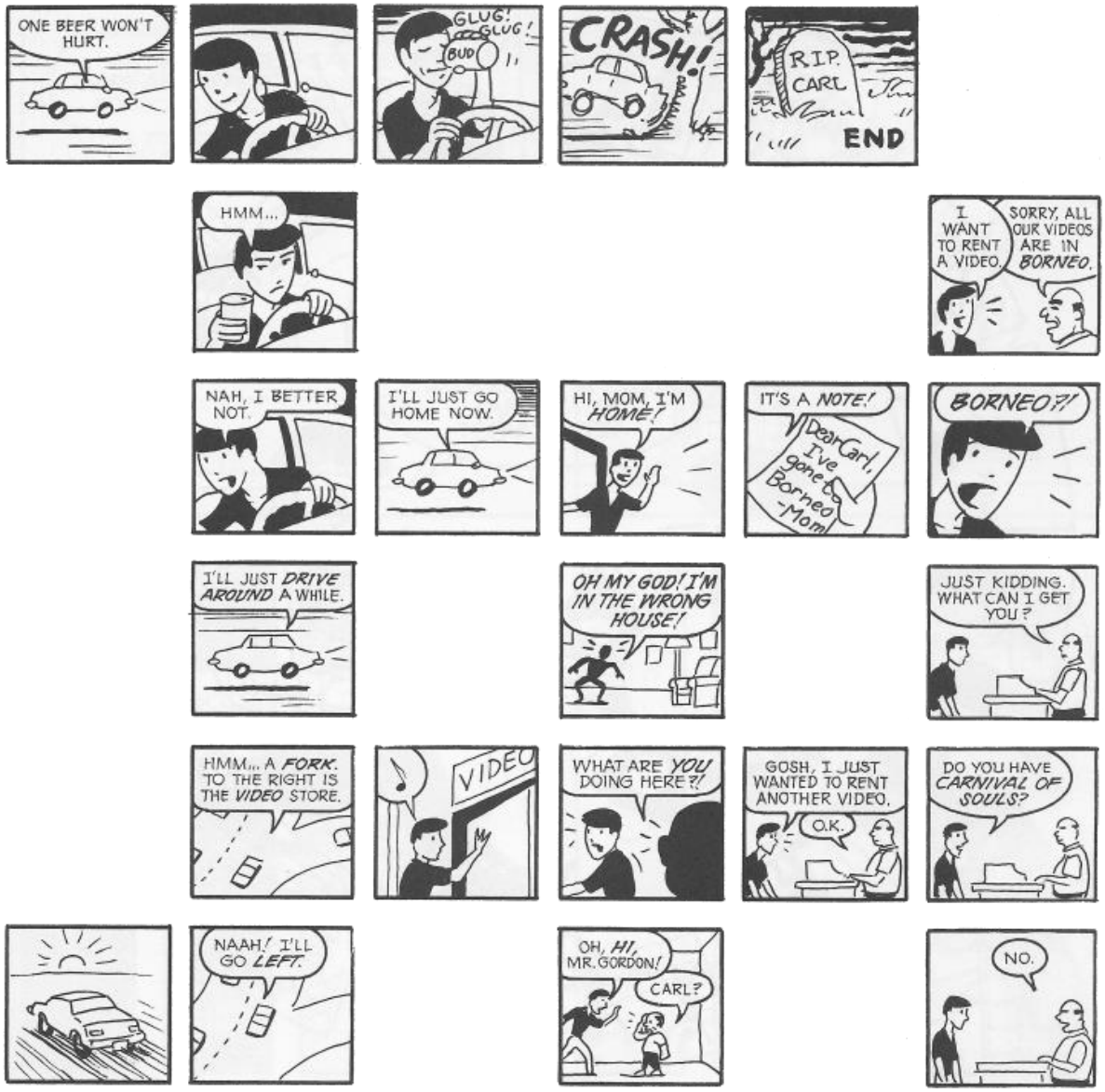


Figure 3.3.2.1 - Creating branching narratives through the arrangement of panels (McCloud 1993, p. 105)

Although there is no anticipation of a ‘user’ interacting with this comic, the variable possibilities in the outcome of events is reminiscent of interactive stories such as Choose Your Own Adventure books and digital games discussed in Chapter 1 and Chapter 2. McCloud (1993, p. 105) therefore provides additional evidence that panels in comics may lend themselves to portraying branching narratives and visualising interactive stories, as their existing conventions of visualising stories can be readily adapted to these purposes.

3.3.3 – Hypercomics

An extension of the branching principles portrayed in McCloud’s (1993, p. 105) comic can be seen in Figure 3.3.3.1, which is an example of what Goodbrey (2013) terms a ‘hypercomic’. The term ‘hypercomic’ is derived from ‘hyperfiction’, which is a medium of digital texts in which users can explore the outcome of events in a similar manner to that of Choose Your Own Adventure books, combined with the possibility of exploring different perspectives in a story (Goodbrey, 2013). In the hypercomic from Figure 3.3.3.1, the user is initially presented with a layout of the entire comic on screen. This can be seen at the top of Figure 3.3.3.1. The user can zoom in and out of this comic, as well as pan and scroll its layout to explore the different branches, as depicted in the lower images of Figure 3.3.3.1. Although hypercomics can contain branching possibilities similar to that of McCloud’s (1993, p. 105) in Section 3.3.2, the comic shown in Figure 3.3.3.1 contains branches that depict different perspectives rather than possibilities, and stem from the core path that runs horizontally across the centre of the comic. This central core of the comic is visualised to the user by containing larger panels more uniformly arranged than the branches that splinter away from it. The shorter paths with smaller panels lead both into and away from this core path, simultaneously creating new narratives and embellishing the existing story. For the purposes of designing interactive stories, the hypercomic approach could be employed to visualise different options and parallel narratives

in an alternative manner to that of Eisner (2008a, p. 83) discussed in Section 3.3.1. In addition, the central panels within the comic in Figure 3.3.3.1 anchor the story in the same way that inevitable events in a foldback structure would contain the branches of an interactive story. The different paths and/or perspectives within the comic would consequently correspond with lower levels of abstraction.

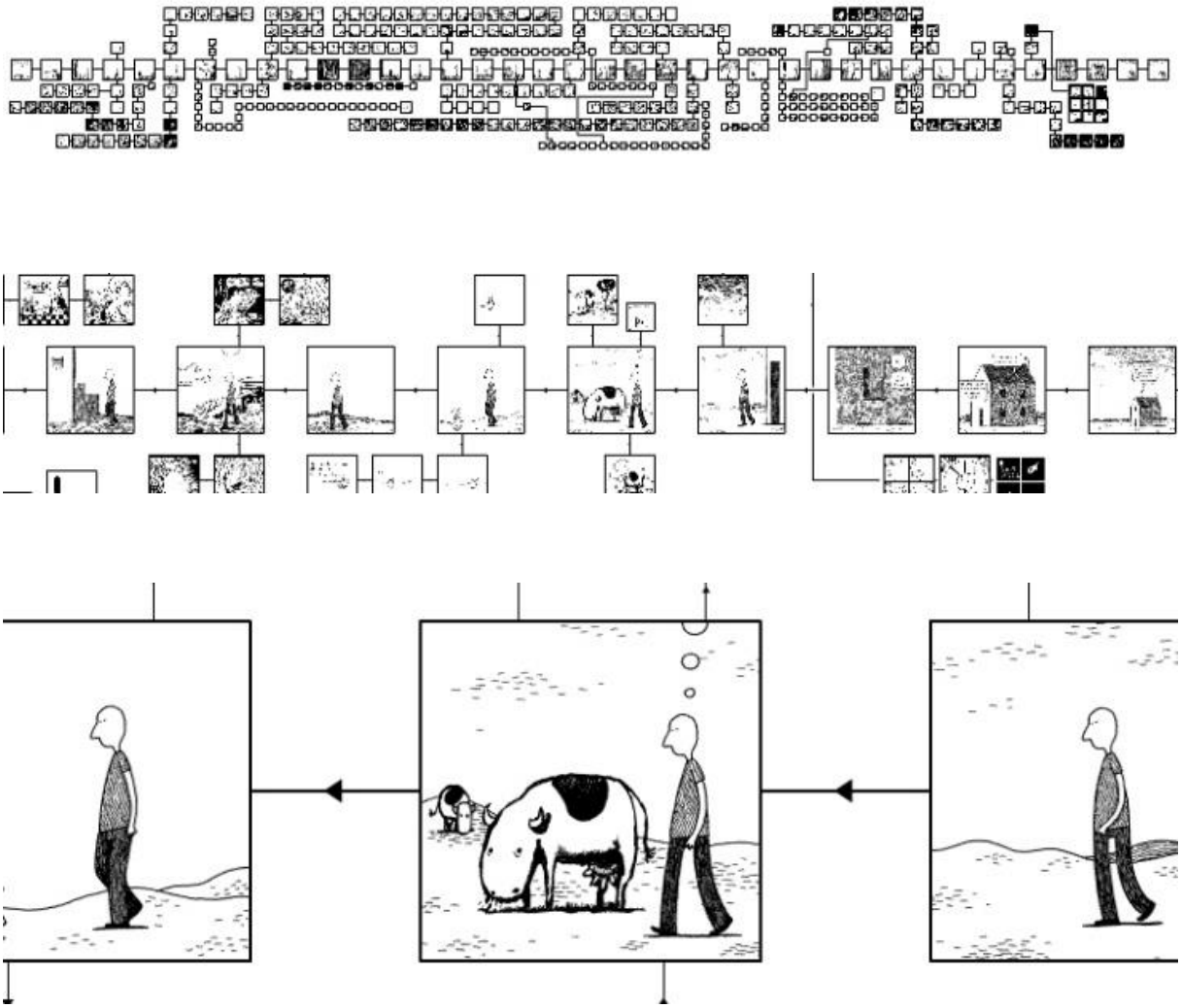


Figure 3.3.3.1 - Zooming into Gravett et al.'s (2003) hypercomic

3.4 – An Approach to Designing and Visualising Interactive Stories with Comics

The validity of employing comics within the processes of designing interactive stories has been demonstrated in this chapter by aligning theories of comics with those of interactive stories; reinforced with practical examples. To some extent, this already provides a theoretical foundation that could be used to inform the design of interactive stories using comics. However, while the examples in Section 3.3 each contain elements of the preceding theories, none of them can be said to fully represent the alignment of approaches to comics and interactive stories as explored in Section 3.2. In addition, the theoretical and practical explorations explored serve to demonstrate that the identification and portrayal of variables and the problem of combinatorial explosion may not have been resolved in these studies. The hierarchical structures discussed so far, including abstraction levels, story grammars and visual narratives, whilst permitting interactions at low levels for users, could potentially result in large amounts of content that would need to be created by designers. The most concise solution proposed at this stage can be seen in Figure 3.2.3.3, wherein the categorisation of phases of panels according to abstraction levels can be combined with foldback structures. However, this structure does not provide the variable outcomes of events that are associated with interactive stories, and there is no limit to the number of embedded phases that could be integrated. McCloud's (1993, p. 105) comic from Section 3.3.2, on the other hand, illustrates that folding back upon branch points can allow for variation within phases, but can also lead to multiple and varied endings that could be difficult to design and produce. It could be argued that this is due to the abundance of possible points the branches could fold into and the lack of inevitable events. However, Gravett et al.'s (2003) hypercomic from Section 3.3.3 shows that having a single narrative thread of inevitable events can still give rise to a large number of branches. In the same way that a combination of approaches from Chapter 2 may need to be combined to design interactive stories, the

approaches explored so far in Chapter 3 may need to be combined to design and visualise interactive comics.

3.4.1 – Visualising Hierarchies of Narrative Structures in Comics

This thesis proposes an approach to design in which the contents of existing panel layouts in comics are manipulated in order to visualise hierarchies of abstraction, variables, and contain the possible branches in interactive stories. This approach has been informed by Eisner's (2008a, p. 131) comic strips portrayed in Table 3.4.1.1, mapped against the theories explored so far in the thesis. In Table 3.4.1.1, Eisner demonstrates how the different use of sound, dialogue, and caption descriptions can be applied to the same sequence of images; subtly changing their potential meanings or interpretations. Though the arc of the character's setting and actions is contained within the images, it is embellished or modified with details related to the context and/or thoughts of the character. These details can be aligned with different levels of abstraction, and therefore represent the kind of modifications that could be possible in interactive versions of these comics. Within interactive stories, branches could be created and variables explored by embellishing existing panel contents and narrative structures with additional text and images, in the same way that Eisner modifies the contents of the panels shown in Table 3.4.1.1. In interactive comics, users would interact with elements within panels, which would impact the visual and narrative information displayed within the panel being used. This would visualise the embellished hierarchies of story content within the panel, but it may also affect subsequent panels in the story depending upon the level(s) of abstraction to which the interaction is assigned. It is therefore the position of this thesis that Eisner's (2008a, p. 131) comic strips mapped against levels of abstraction and story structures provide the foundation of a process for designing and visualising interactive stories.

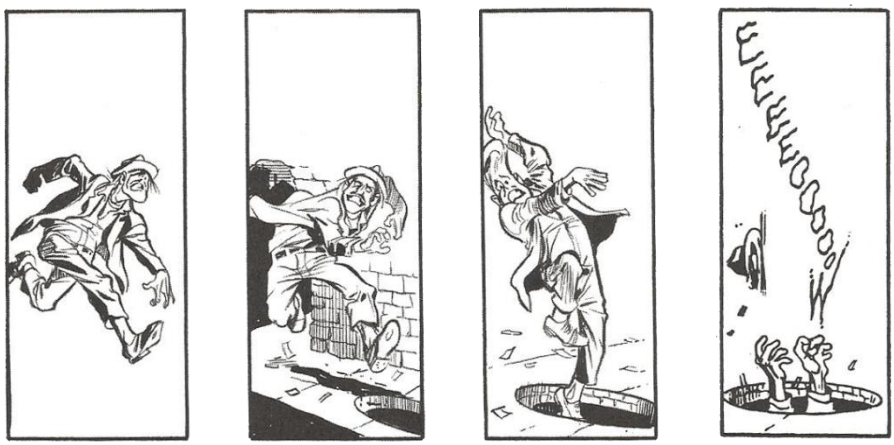
ABSTRACTION	PANELS			
	ESTABLISHER	INITIAL	PEAK	RELEASE
HIGH LEVEL				
MEDIUM LEVEL				
LOW LEVEL				

Table 3.4.1.1 - Eisner's (2008a, p. 131) illustrations of the impact written descriptions can have upon a comic strip, mapped against Aylett et al.'s (2008a, 2008b) levels of abstraction and Cohn's (2013b) visual narrative structure

The theoretical and practical evidence explored so far indicates that this method would have several advantages to designing interactive stories compared with other approaches in which additional content is embedded in or adjoined to comics. Firstly, the high level abstraction of the story would be contained within the layout of panels, and would limit the ambiguity of the comic's structure that could result from adding additional panels. In Table 3.4.1.1, for example, the alterations to Eisner's (2008a, p. 131) comic at lower levels of abstraction do not impact the assignment of the panels according to Cohn's (2013b) categories. Although alterations within panels may create forms of embedded phases or episodes, the layout of panels would facilitate the management of high level content by providing a fixed level of abstraction. This leads to the second advantage: that the content produced at lower levels of abstraction would be contained within the structures and contents of panels at the top level, and therefore limit the potential of combinatorial explosion. Finally, an approach employing a combination of McCloud's (1993) visual abstractions, as discussed in Section 3.2.1, and Eisner's (2008a, p. 83) depiction of parallel narratives, as discussed in Section 3.3.1, could be employed to provide a foundation of content that allows alterations to be made at lower levels of abstraction within panels whilst visualising a coherent story at a high level. Rather than employ panels simply as units of stories that can be added to existing structures of panels, hierarchies would be visualised within panels in this approach, and convey the changes of variables through visual and textual alterations.

3.4.2 – Designing Interactive Comics

Table 3.4.2.1 provides an overview of how interactive comics could be designed, and how users could interact with story content in comics. Here, the top level of the story is set within the contents already drawn in the comic. This would represent the broad arc of the story, containing what could be termed an Establisher or Setting at the beginning of the comic, as well as what

might be termed a Release or Resolution at the end. Depending upon the length of the comic, some embedded phases or inevitable events may already be rendered within the comic, which could exploit the ambiguity and abstraction possible through drawings. Essentially, the designer would determine the information fundamental to the story they wish to tell and render the comic accordingly. At lower levels of abstraction, the user can embellish the arc by changing variables and/or embedding phases or episodes through their interactions. Additional images and/or text would be displayed within the panels as a result of the user's interactions, and complement the existing visual and written information. The cumulative result of the user's combined actions would consequently result in additional images and/or text being displayed, which would complete the narrative.

The authorship of stories adopting this approach would be contained within the top level, and the possible branching would be limited by the number of panels, the possibilities within the panels, and the feasibility of possibilities within the pre-rendered arc in anticipation of users' comprehension, based upon theoretical models and/or evaluations. Certain panels are consequently adapted from their established convention of displaying units of stories in comics to presenting branch points within interactive stories. This could be seen as a limiting factor; restricting what might be possible for both designers and users in terms of possible branches and endings. Nevertheless, the approach provides a concise yet comprehensive method of designing and visualising interactive stories through comics that accommodates related theoretical and practical explorations, while circumnavigating the pitfalls of designing for complex hierarchies and combinatorial explosions.

ABSTRACTION	COMIC
HIGH LEVEL 	STORY Contains panel structure, images and written materials corresponding to the broad arc of the story (user has no control over the contents)
MID LEVEL(S) 	PHASE / EPISODE / EVENT Contains variable images and/or written materials within panels (user controls the additional content that occupies the panels to create phases or episodes within the story arc)
LOW LEVEL(S) 	NARRATIVE Presents images and/or written materials to user (story responds to user's actions and displays resulting narrative(s) within the panels)

Table 3.4.2.1 - A process for designing and visualising interactive stories through comics, illustrated with images from McCloud's (1993, p. 31) visual abstractions

3.5 – Conclusion

This chapter has demonstrated the theoretical overlap between comics, stories and interactive stories. Though this overlap has been recognised in previous work (McCloud, 1993, 2000;

Gershon and Page, 2001; Gravett et al., 2003; Lu and Shen, 2008; Segel and Heer, 2010; Ma et al., 2012), this chapter contributes an in-depth comparison of theories leading to a process of designing and visualising interactive stories through comics. This process combines the structural benefits of comics with the flexibility of manipulating the contents of panels, which can visualise the units of stories, present branch points within interactive stories, and reveal hierarchies of story content to users. The method differs from previous approaches that extend panel structures, and limits the possibility of combinatorial explosion. Though this may result in a more limited number of possibilities within some interactive stories, it also provides a more informed framework for managing, visualising and designing interactive story content when compared with other approaches.

Although it counters limitations of previous approaches to designing interactive stories, the focus upon the delivery of content through interactions with comics could be seen as a limitation. Mateas (2001), for example, as discussed in Chapter 2, attempts to incorporate the responses of users within his Aristotelian model for interactive drama, whereas the approach described in this thesis employs designs based upon readings that creators anticipate. Although these designs can be informed by theories of interactive stories, closure and mental models, they do not accommodate the range of potential responses that could impact the experiences and comprehension of interactive comics. However, evaluations of the Façade, which is an interactive drama informed by Mateas' approach (Mateas and Stern, 2003), show many potential aspects of interactive stories that could be studied (Knickmeyer and Mateas, 2005; Dow et al., 2007; Sali and Mateas, 2011; Seif El-Nasr et al., 2013), which may be beyond the scope of a single model. Therefore, rather than attempt to incorporate user responses within the theory of an interactive comic, this thesis explores the potential for comics to be used as tools for evaluating interactive stories, which could be used to inform future designs.

CHAPTER 4: EMPLOYING COMICS TO EVALUATE INTERACTIVE STORIES

4.1 – Introduction

Through an exploration of theories and methods related to the design of interactive stories and comics in Chapters 2 and 3, the thesis responds to Research Questions 1 and 2 from Chapter 1 with an approach to designing and visualising interactive stories through comics. This approach anticipates how users could explore stories, but does not incorporate how users might respond to them. Whilst approaches exist that attempt to take this into account, their relevance is undermined by the range of possible responses to interactive stories that could be measured. Chapter 4 explores previous work that evaluates some of these responses. This includes relevant examples in stories, interactive stories and visualisations, which are analysed in relation to either user experiences or comprehension. Evaluations of interactive stories tend to focus upon user experiences, and it is argued that, although user experiences are important considerations for designers of interactive stories, exploring the comprehension of stories can also provide important data related to the intended experiences designers wish to cultivate. Related work into visualisations demonstrates that comprehension of visual data is prioritised in evaluations, which can inform approaches to evaluating visual stories. A form of analysis in which readers' responses to questions about content are mapped against the layout of the comics is proposed as a potential method for exploring comprehension of interactive stories. It is also argued that this method could be aligned with evaluations of user experiences, providing insight into the correlation between interactive experiences and comprehension.

4.2 – Story Comprehension

Although evaluations of interactive stories tend to focus upon users' experiences rather than their comprehension of stories, previous approaches to story comprehension do exist that could be applied to contemporary media. As early as 1926, Piaget (1959) studies recollections that children aged six to eight years give of stories, which provides a general understanding of some of the associated characteristics of children telling stories, such as a disregard for the temporal order of events (Fraisse, 1976). The influence of Piaget's methods can be seen in more recent studies (Brown, 1975; Mandler and Johnson, 1977; Mitchell and McGee, 2011), which in recall tasks simply involve children verbally retelling stories that are presented to them. Though the results could be due to the expository skills of children rather than their ability to comprehend temporal sequences in stories (Brown, 1975), the studies highlight that the task of recollection is something children find particularly difficult (Mandler and Johnson, 1977).

4.2.1 – Visualising Story Comprehension

Following the work of Piaget (1959), Brown (1975) argues that studies into the abilities of children to comprehend stories should include measures of recognition and reconstruction, as well as recall, in order to be fully comprehensive. Of note within the context of the present thesis and the study of comics is that Brown uses pictorial stimuli and sequences of images to both present stories and measure recognition and reconstruction in children. Figure 4.2.1.1 shows the pictorial elements provided to children to create narratives and Figure 4.2.1.2 shows how these elements could be combined to form a coherent narrative: "The cat put on his glasses and went for a ride in his plane and then the weather got bad and he was struck by lightning" (Brown 1975, p. 159). Brown (1975) shows that, when provided with the materials depicted in Figure 4.2.1.1, children perform better at recognising and reconstructing stories than when

asked to perform oral retellings without them, and are also able to create original, coherent narratives from these materials. This provides a method for applying pictorial elements to evaluate story comprehension, which could inform evaluations of interactive comics.

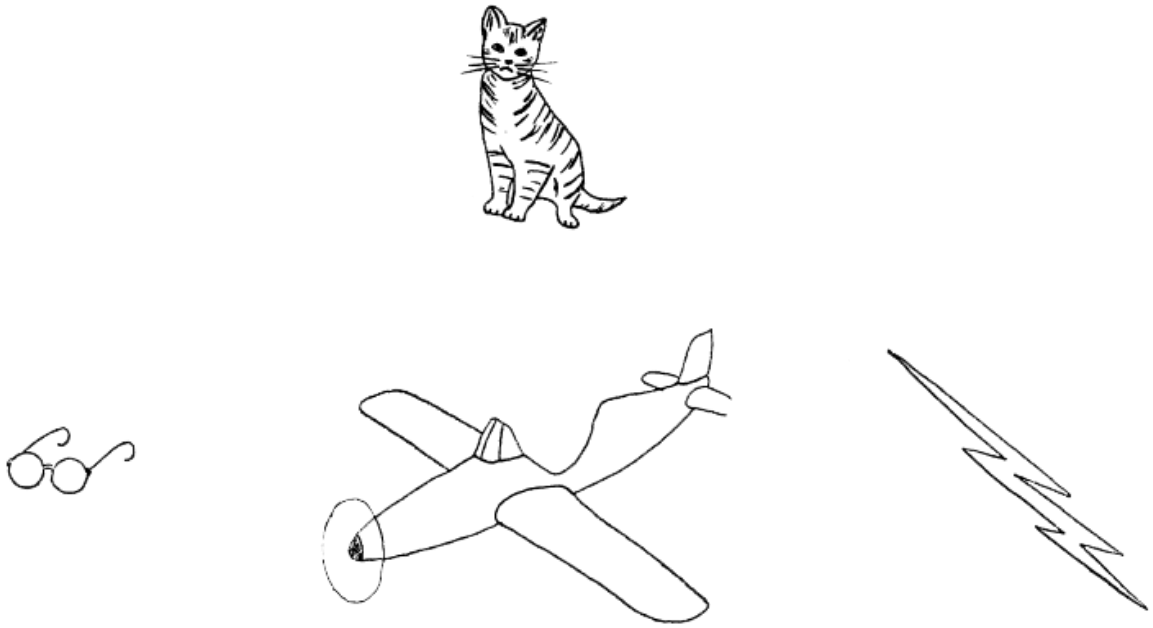


Figure 4.2.1.1 – The pictorial elements that are provided in Brown's (1975, p. 158) study

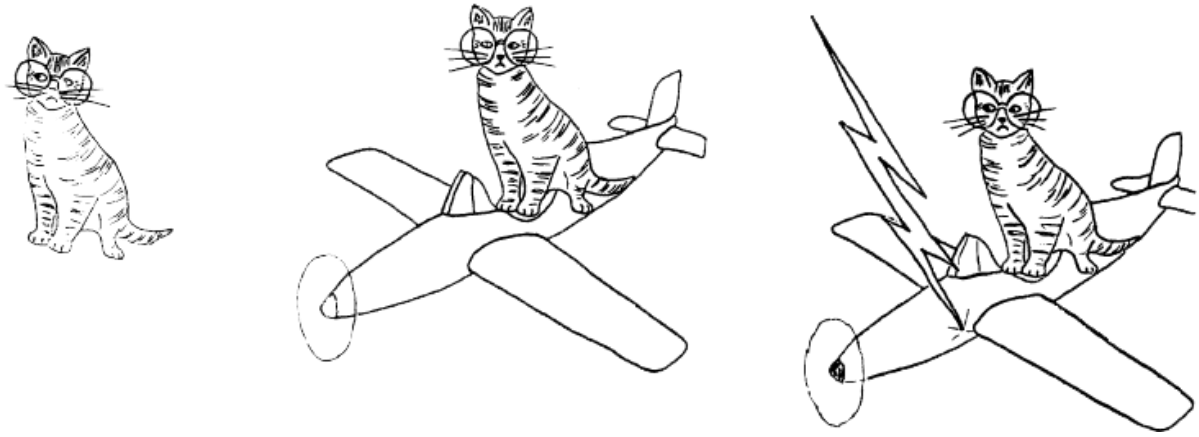


Figure 4.2.1.2 - A pictorial representation of a coherent narrative (Brown 1975, p. 158)

4.2.2 – Story Recollections

In spite of Brown's (1975) recognition of other aspects that can be measured, recollections or retellings have been used extensively in subsequent studies of comprehension (Fletcher, 2006). In an experiment exploring the validity of story grammars, Mandler and Johnson (1977), ask subjects to orally recall stories they are told, and employ procedures to ensure that stories' recollections are 'verbatim', and not simply summarisations. Their findings indicate that the age of participants and the structure of story materials has an impact upon these recollections. In their method, recollections are mapped against the structure of the story grammar Mandler and Johnson employ, and it is argued that sequencing is not an issue for their participants, regardless of their ages, in stories that adhered to this structure. Although Mandler and Johnson (1977) are not concerned with summaries, it may be useful to distinguish between verbatim and summarised accounts of interactive stories in relation to low and high levels of abstraction of interactive stories respectively. It is also useful to note the practice of categorising responses against the content of stories, which has influenced subsequent approaches to studying the comprehension of stories and interactive stories.

4.2.3 – Categorising Qualitative Data

Whilst the range of practiced methods have gradually increased since the work above, many studies into comprehension employ questionnaires and protocol analyses, combining quantitative and qualitative methodologies (Moissinac, 2004; Fletcher, 2006). Protocol analyses can be retrospective, such as the recollections described above, or 'think aloud', which is often applied to studying the comprehension of tasks in workplaces (Walker, 2004; Bainbridge and Sanderson, 2005). The qualitative aspect of these studies is the categorisation of data according to either patterns that are preconceived, such as story grammars, or those that emerge through the analyses of data. The qualitative protocol data can then be quantified and

assigned to these categories. There are critiques to approaches that employ preconceived categories in studies of stories, which challenge the legitimacy of the codification of responses due to the assumed validity of parallels to linguistic structures (Black and Wilensky, 1979; Garnham, 1983; Moissinac, 2004). Nevertheless, it is potentially useful to consider the potential benefits of these approaches as well as their limitations, and how they could inform studies of interactive comics.

4.3 – Interactive Stories

As stated in Chapter 1, the terms 'reader' and 'user' can be interchangeable in studies of stories and interactive stories, which may reflect some uncertainty over the possible measures that could be explored. Brown (1975) recognises that the different methods of studying story comprehension can lead to varying results; an outcome that could be more manifest in studies of digital interactive stories where the possible measures are more varied.

4.3.1 – User Experience and Comprehension

Qualitative methods such as observations (Gee, 2001), debriefings, interviews (Dow et al., 2007; Mitchell and McGee, 2011; Seif El-Nasr et al., 2013), oral retellings (Pearman, 2008), focus groups (Poels et al., 2007), retrospective protocols (Knickmeyer and Mateas, 2005) and think aloud protocols (Pope, 2010) have been used in studies of interactive stories, but of these examples only retellings have been employed to study story comprehension as opposed to user experience. The different methods employed to study user experiences reflects the breadth of different aspects of interactive stories that could be evaluated, making it difficult to identify how the results of these studies can relate to one another (Aylett et al., 2011). Difficulties with evaluating interactive stories consequently stem from the various aspects that could be explored and the potentially limited significance of the results.

Another recognised limitation amongst these studies is the contentious nature of employing qualitative analyses in the context of research related to human-computer interaction, or HCI. Höök et al. (2003) discuss the dilemma of studying interactive art from an HCI perspective, arguing that, whilst many theorists assume that processes of interacting with art are inherently subjective, HCI researchers aim to find objective results into the effects of using devices. As they state; "While HCI evaluation is often approached as an impersonal and rigorous test of the effects of a device, artists tend to think of their systems as a medium through which they can express their ideas to the user and provoke them to think and behave in new ways." (Höök et al. 2003, p. 242). This dilemma may reflect the perceived differences between studying user experience and comprehension, which could be deemed to be objective and subjective respectively, and could explain why most researchers of interactive stories study user experiences. This can also be compared with the dilemma of creating designer or user-led interactive stories, as discussed in Chapter 2, or the issues identified in studies of story comprehension discussed in Section 4.2. Nevertheless, any study involving qualitative data can be prone to subjectivity, including those investigating user experiences. Though the categorisation of qualitative data can allow responses to stories to be quantified, the legitimacy of this process can be subject to scrutiny due to the inherently subjective nature of both the data and their categorisation.

Researchers can employ various techniques to counter this subjectivity in studies involving qualitative data. In studies of stories and interactive stories, multiple researchers can be used in the categorisation process to qualify one another's assessments and compensate for each individual's subjectivity (Mandler and Johnson, 1977; Walker, 2004; Bainbridge and Sanderson, 2005). Third parties have also been used in the analysis and classification of interview data to avoid any potential issues of bias (Seif El-Nasr et al., 2013). In other cases the

application of predefined categories can provide structure to responses and facilitate the identification of patterns, particularly when comparisons are made. Such an example can be seen in the work of Pearman (2008), which is a rare example of a study into comprehension of interactive media. In this study, children's readings of interactive digital texts presented on CD-ROM are compared with those of traditional printed texts. The method involves categorising oral retellings against Morrow's (1986) 10-Point Scale of story comprehension, which is derived from previous approaches to story grammars and schema and allows comprehension to be scored against story structures. Pearman's (2008) results show that the mean retelling scores of CD-ROM texts are significantly higher than those of traditional texts. Although the validity of employing such categories can be challenged, the results at least demonstrate the potential application for such categories to be employed to explore differences between media.

Pearman's (2008) study also finds that illustrations in both interactive and traditional formats facilitates engagement, which is worth noting in the context of exploring visual stories. However, the media explored do not compare with interactive stories as defined within this thesis. In Pearman's (2008) study, digital texts are embellished with hypertext links to rich multimedia content rather than optional story content. Although this could be defined as a form of branching, as the user is encouraged to deviate slightly from the main narrative path, it does not require the creation of additional narrative content to accommodate branching by either designers or artificial intelligence systems. Therefore, whilst they contain interactive 'hot spots' and illustrations, these texts do not compare directly with the branching stories explored in the present thesis.

4.3.2 – Hypertext Stories and Hyperfiction

Hypertext stories and hyperfiction are the textual predecessors to hypercomics as discussed in Chapter 3, and have more obvious parallels with the branching comic process proposed in this

thesis than the texts investigated by Pearman (2008). One characteristic of hypertext stories is that the order in which their content is presented can be altered, which Urakami and Krems (2012) have studied specifically in relation to the impact this could have upon story comprehension. In accordance with studies of mental and situation models, as discussed in Chapter 3, Urakami and Krems (2013) investigate whether these models facilitate comprehension. Their method involves categorising and comparing recollections of hypertext story events presented to participants in different sequences. Based on the responses, it is argued that comprehension is facilitated by the interdependent construction of temporal and causal links between events in a sequence. This can be created in all sequences if events are causally related, but the 'causal distance' between events can affect their perceived correlation (Urakami and Krems, 2012). In the context of branching comics, it is worth noting that this study reflects those which Cohn et al. (2012) have done where slide arrangements are changed in comics based upon Cohn's (2013b) visual narrative structure and semantic relatedness. Instead of categorising recollections, these studies calculate reaction times of participants in tasks related to the specific claims of Cohn's (2013b) theories. Whilst individual images can accommodate a wealth of meanings, it is argued from these results that meaning(s) can be inferred through sequences of panels based upon their semantics and structure (Cohn et al., 2012; Cohn, 2013b). As this approach is designed specifically to explore theoretical narrative structures, it may not be appropriate for exploring responses that could inform future designs of interactive stories. However, while reordering events or panels is not a feature of the branching comic approach proposed in this thesis, the methods employed by Urakami and Krems (2012) could be adapted to explore whether users revisit previous branch points and explore different options in interactive comics, and the impact this has upon comprehension.

In keeping with evaluations of interactive stories, other studies of hypertext stories explore how users interact with stories rather than comprehend them. In a study of hyperfiction, Gee (2001) uses observations, questionnaires and debriefing sessions to determine the usability of interfaces when participants explore the story spaces of hyperfiction, and produces recommendations based on the findings. More recently, in their study of the re-readability of hypertext stories, Mitchell and McGee (2011) employ a modified version of a Piagetan clinical interview to explore initial reactions to stories and motivations for re-reading. This study finds that readings of hyperfiction are goal-oriented, and that users stop exploring narrative branches after a period of exploration due to the lack of an obvious purpose, or goal, of doing so. Although this method is derived from the work of Piaget (1973), the focus is upon the cognitive processes involved in the changing tasks and requirements of exploring hyperfiction, rather than the impact these tasks could have upon the comprehension of stories presented within the medium.

The fact that interactive stories involve navigating materials in different ways to other forms of stories has prompted a general interest into the effects of their interfaces, both theoretical and empirical. Mangen (2008) argues that, apart from the superficial differences in the way users may interact with texts presented digitally and on paper, the differences between texts presented on paper and screen are 'phenomenological', as there is a tangible difference between the 'visible' and the 'invisible' in the media. Paper-based books, for example, can be held and flicked through, meaning that, though the stories may not be visible on the pages until they are read, readers will have a sense of the length and body of the works through their physical presence. E-books, on the other hand, which display textual materials sequentially on electronic devices, employ various visualisation techniques to simulate this indication of the whole content, such as scroll bars or thumbnail images of remaining and/or preceding pages. Although

these are not interactive stories, comparisons can be identified in the theoretical distinctions between books and E-books and those of stories and interactive stories regarding their methods of navigation, which is reflected in the empirical studies of hyperfiction described above.

4.3.3 – Façade

There are many other types of interactive stories besides hyperfiction that could be described in relation to evaluation, each exploring different phenomena with some unique facets to their methods. As Mateas' and Stern's (2003) Façade has been discussed from a design perspective in Chapter 2, evaluations of this interactive drama are worth comparing with its theoretical foundation. In addition, studies into Façade provide additional evidence that there are commonalities between studies into stories and interactive stories, which suggest that protocol analyses would be suitable for studying interactive comics. Knickmeyer and Mateas (2005), for example, use retroactive protocol analysis and post-experience interviews to assess various qualities of Façade. In this study, the issues of investigating inherently subjective media identified by Höök et al. (2003) are reiterated when the authors acknowledge the difficulties of studying software when there is no obvious task that can be made more efficient or easier by the program. Therefore, protocols are coded according to broad categories of immersion and engagement including Agency, Fantasy, Challenge, Storyline, Miscellaneous and Representation. The specific focus of the study is upon ‘interaction breakdown’, and its impact upon immersion and engagement in Façade. Similarly to the findings of Mitchell and McGee (2011) in relation to hyperfiction, Knickmeyer and Mateas (2005) find that the experience of using Façade could be goal-driven, as users are motivated to continue the experience through the adjustment of their goals and expectations, even when interactions ‘failed’. Though the different categories that emerge through protocol analyses and interviews in the Knickmeyer and Mateas (2005) study could inform approaches to comprehension and future designs, they

are only anticipated at a relatively abstract level through the broad concept of ‘materials’ in Mateas’ (2001) original theory discussed in Chapter 2. Therefore, abstract conceptions of user responses may be all that is possible with theory prior to evaluating interactive stories.

Additional studies of Façade employ the categorisation of protocol data to explore related phenomena. Dow et al. (2007) use open-ended interviews and observations to explore responses to different interfaces with which users can participate with Façade, and code responses according to phenomena related to presence and engagement. Their findings indicate that there are not only different categories of presence and engagement, but also different categories of users who engage with the experience in different ways. Therefore, the authors conclude that measures of presence are not necessarily indicative of measures of engagement, as different users respond differently to the various aspects of the Façade experience (Dow et al., 2007).

More recently, Seif El-Nasr et al. (2013) employ a psychologist to categorise interview data related to the general experience of Façade’s interactive narrative, confirming the implications from the Knickmeyer and Mateas (2005) study that the experience of Façade is goal-oriented, and adding that some kind of feedback system may be beneficial to users. Although it could be argued that these results can be expected in evaluations of the same experience, the variations in the approaches could have also lead to inconsistencies. In addition, the fact that similar phenomena have been seen in hyperfiction (Mitchell and McGee, 2011) indicates that goal-oriented experiences may be common to interactive stories. Therefore, whilst various results can be witnesses when studying interactive stories, comparing these results may gradually reveal common traits that can inform future designs.

4.4 – Story Visualisations

One of the issues with investigating interactive stories is that there are no obvious tasks that can be evaluated (Höök et al., 2003; Knickmeyer and Mateas, 2005; Seif El-Nasr et al., 2013). This is not the case with data visualisations, which need to present visual information comprehensibly in order to be usable (Shneiderman, 1996; Gershon and Page, 2001). With the exception of video games (Medler et al., 2011; Moura et al., 2011), visualisations have rarely been employed in interactive stories at the time of writing, though work is emerging in this area. For example, Sali and Mateas (2011) explain how experimental visualisations have been applied to a range of Choose Your Own Adventure (CYOA) books and Façade. In the case of the CYOA books, visualisations are used to depict the structure of their content rather than to support or reflect their comprehension, whereas the visual information on Façade shows how users interact with the 'story space' depending upon the interface(s) chosen (Sali and Mateas, 2011). It is argued that these visualisations enable researchers to comprehend the designs and experiences of interactive stories, but whether similar methods can be employed to explore how users comprehend interactive stories remains unexplored.

Other research explores the potential benefits of integrating storytelling techniques in data visualisations. Segel and Heer (2010) and Ma et al. (2012) use the analogy of storytelling to discuss examples of visualisations comparing the strengths and weaknesses of different techniques. There is discussion over the dilemma of balancing the requirements of designers, scientists and users in data visualisations, and the different interactions that users could, or should, be permitted in order to facilitate their engagement with and understanding of data (Segel and Heer, 2010; Ma et al., 2012). This consideration is reflective of the dilemma facing creators of interactive stories and the balance between designer and user-led experiences, and those that Höök et al. (2003) discuss in relation to subjectivity and objectivity in art and HCI.

Through comparative case studies, Segel and Heer (2010) argue that some of the best data visualisations are those that provide their users with brief narrative overviews, or 'snippets' to facilitate comprehension, which is comparable to the high level of abstraction in interactive comics proposed in this thesis. In some cases, the level of detail given in these 'snippets' is created intuitively by the creator(s) of these visualisations, having taken into account the method(s) of presenting the information and the opportunities offered to the user(s) (Segel and Heer, 2010). In other cases, studies into visualisations can reveal the misinterpretation of data by users, which can inform future designs (Ma et al., 2012). However, while the analogy of storytelling is deemed to be beneficial from a theoretical perspective, the authors of these studies do not present empirical data to support their claims.

Though it does not relate to storytelling in visualisations specifically, the work of Diakopoulos et al. (2011) may provide some insight into what can be expected of responses to interactive visual stories, such as branching comics. In this study, a system of logging each user's interactions as well as a questionnaire post-task are employed to explore the impact of game mechanics within an interactive visualisation. The study suggests that 'game-y' designs redistribute attention across the visualisations, rather than enhance the comprehension of the data being represented (Diakopoulos et al., 2011). As this study is concerned with specific tasks, the methodology employed may not be appropriate for exploring comprehensions of stories. Nevertheless, it provides an example of studying the impact of interaction upon the comprehension of visual data, and the results of studies into comics may confirm whether simple interactions related to branches in stories can lead to equivalent effects.

4.5 – An Approach to Evaluating Interactive Stories through Comics

The present chapter shows that, though there are multiple aspects of both comprehension and user experiences that can be measured, protocols have been common throughout studies of comprehension and user experiences in stories and interactive stories. These protocols are coded against either pre-existing criteria in relation to comprehension or both pre-existing and emerging criteria in user experiences. In keeping with approaches to comprehension, this thesis proposes a method wherein protocols are mapped against the pre-existing visual structure of comics. While comprehension has been explored in relation to specific aspects of certain types of interactive stories (Urakami and Krems, 2012), the present approach is designed to explore phenomena that may not be anticipated. This method is applied in the studies in Chapters 5 and 6. Following these studies, the thesis also proposes that additional protocol and observation data related to user experiences are taken and categorised, either following or during the experience of using comics. This is done in Chapters 6, 7 and 8. Finally, it is argued that methods derived from theories of role-play in interactive story development can be employed to evaluate the design and consumption of interactive comics, which is explored in Chapters 7 and 8. The combination of these methods has the potential to reveal patterns in comprehension and user experiences related to interactive stories.

4.5.1 – Comics as Protocol Visualisations

As discussed in Chapter 3, comics present narrative information visually to readers as units within layouts of panels, which differentiates them from time-based visual media such as animation or film that present narrative units sequentially to users (McCloud, 1993; Gershon and Page, 2001). While previous approaches to story comprehension employ categorisations based upon theories of story structures, such as story grammars, the aesthetic structure of

comics is already visualised in their layouts; which is one of the proposed benefits of using comics to design interactive stories in this thesis. Though it is not explicitly stated, the use of pictorial materials in Brown's (1975) study of story comprehension suggests an assumed validity of assigning visual elements to story structures in evaluations. In addition, the work of Sali and Mateas (2011) shows the potential of visualising interactions with stories for researchers. Therefore, this thesis proposes visualising responses within the layout of comics being tested as one method of identifying patterns in responses, which could then be aligned with story structures and/or users' responses. Though the categories of story structures can be challenged, one benefit of employing comics in evaluations is that the subjectivity of categorising data is limited due to the pre-existence of visual material to which these categories can be assigned.

An example of this approach can be seen in Figure 4.5.1.1, which is taken from the study in Chapter 6. The image at the top shows one possible outcome of the interactive comic studied once all options are selected. The image at the bottom shows how the elements of the comic can be categorised, and how heat maps can represent quantities of responses that correspond with these categories. Heat maps employ gradients of colour to reflect different levels and amounts of data. When such data relate to populations within geographic locations, for example, colours of different intensity are applied to graphics depicting the layouts of these regions to visualise these populations (Segel and Heer, 2010). Heat maps can also be used in more abstract renderings such as grids (Wilkinson and Friendly, 2009). The approach adopted in this thesis could be described as a moderately abstracted layout of the comic, with partitions roughly placed according to the narrative information contained within the original comic. Once the responses are categorised according to this layout, the visualisation can be overlaid with heat maps to illustrate the different aspects of the comic that readers identify when recalling the

story content. This approach therefore complements existing methods of quantifying qualitative data, and provides a method of visualising data that contributes to the emerging body of work that employs data visualisations to study interactive stories.

While the pre-existence of visual information limits the subjectivity of creating categories, the method anticipates a range of responses based upon levels of abstraction, which could affect the categorisation of visual information. The visual abstraction of Scott McCloud's (1993, p. 31) face discussed in Chapter 3, for instance, visualises the kind of responses that could be received when asking for recollections of a visual story. These abstractions could be described as "a face", "a man's face" or "the face of a man in his late thirties", depending upon both the image being described and the level of detail the user wishes to divulge. In addition, and as discussed in Chapter 3, comics can contain sections of both images and text, which could affect the information recalled. Therefore, the categorisation of information for studying protocols is dependent upon the levels of abstraction in the protocol data, as well as those of the designs and visualisations of the comics themselves.

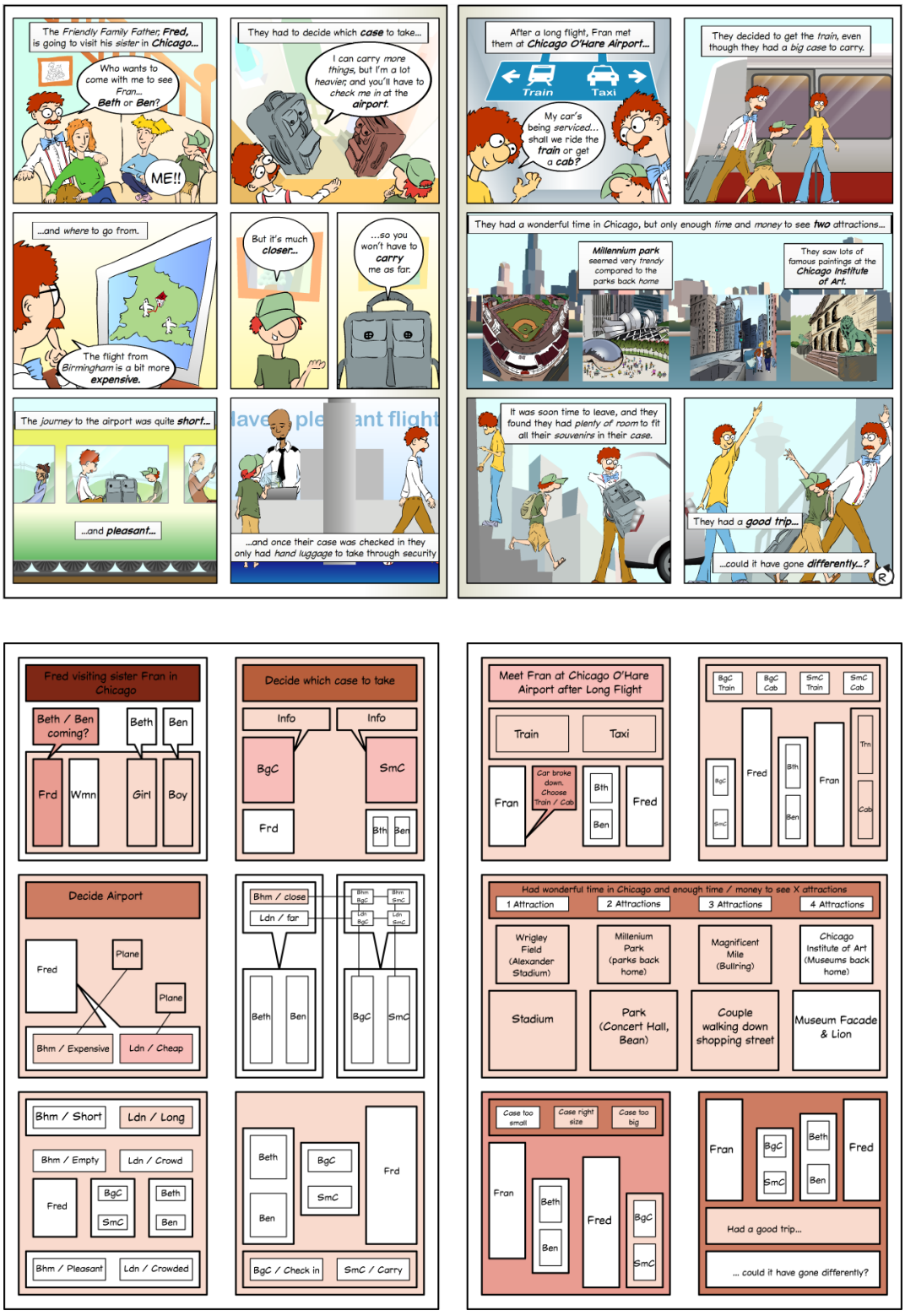


Figure 4.5.1.1 - Example of an application of heat maps to visualise responses to an interactive comic

4.5.2 – Abstraction Levels and Comprehension

In keeping with the concept of abstraction levels, the studies in the thesis explore the possibility of obtaining data related to these levels. As stated in Section 4.2, Mandler and Johnson (1977) distinguish between detailed and summarised accounts for their studies, and make efforts to ensure that accounts are not summaries in order that recollections can be mapped against the specific elements of story structures. In the context of approaches to interactive storytelling, however, both summaries and specific accounts could be mapped against high and low levels of abstraction respectively. This could therefore inform the processes of assigning narrative material to levels of abstraction, and influence future designs of interactive stories. In addition, the use of comics in this approach could contribute to the work in narrative visualisations speculating that the division between visual abstractions or overviews and detailed information is beneficial for comprehension (Segel and Heer, 2010). In the subsequent studies it is shown that there are challenges to obtaining these data, and benefits to adopting different methods.

4.5.3 – User Experience

As stated in the Introduction, and shown in the methods explored in the present chapter, investigations into user experience and comprehension can be hard to distinguish in the context of studying interactive stories, possibly due to the dilemma of identifying the distinctions between roles of creators, users and researchers in the context of studying ‘art’ as identified by Höök et al. (2003). Therefore, the thesis proposes the exploration of user experiences in conjunction with studies of comprehension described in Sections 4.5.2 and 4.5.3; employing similar methods of quantifying qualitative data and aligning them with visualisations of recollections. As shown in Chapter 6, this method can provide valuable insight into trends related to comprehension and experiences, but it may be inappropriate for identifying specific relationships.

4.5.4 – Role-play, Design and Evaluation

In discussions of interactive stories and evaluations, the dilemma of creating content that users can manipulate consistently emerges in both theoretical and practical discussions, which is reflected in the findings in the thesis. The approach to this dilemma adopting abstraction levels, which is fundamental to the process of designing interactive comics in this thesis, is based upon the patterns of interaction between users of role-playing games and their mental or situation models within the framework of their designated roles. Therefore, a method is proposed that incorporates role-playing elements into comic designs by visualising different arrangements of characters in panels depending upon the orientation the comic is read, which correspond with different users. As shown in Chapter 3, the arrangement of panel layouts and orientations in comics can encourage multiple readings, which could be exploited in evaluations as well as designs. Participants can use the comic simultaneously, taking on the role of different characters in the comic and exploring different outcomes for their characters. As shown in Chapters 7 and 8, this allows responses to be obtained from multiple participants simultaneously; aligning previous theories of creating and evaluating interactive stories that can complement other methods and inform future designs.

4.5.5 – Studies

In the subsequent chapters, data related to summaries and detailed accounts are taken via written recollections and verbal protocols. In keeping with the work described in this chapter, the thesis presents a series of studies comparing different presentations of comics. A pilot study involving the effect of rearranging panels in a sequence is presented in Chapter 5, following the work of Urakami and Krems (2012) and Cohn et al. (2012) but in the context of exploring recollections according to levels of abstraction. The results of this study inform the categorisation of data in Chapter 6, where a prototype interactive comic is created and compared with a printed comic

presenting the same branches. This explores the possible impact interaction could have upon visual story comprehension. As well as data related to recollections, Chapter 6 employs observations and debriefing sessions to explore the experiences the different media generate and their potential impact upon comprehension, in keeping with previous approaches to studying hypertext stories and Façade. This study informs the development of a prototype device to deliver interactive comics in Chapter 7 that incorporates paper within a digital interface; separating high levels of abstraction on paper from low levels of abstraction that are projected through materials underneath. This contributes a novel method to presenting and evaluating interactive stories; allowing protocol data related to high and low level abstractions to be attained whilst users are interacting with comics. In Chapter 8, the device is adapted to multi-user comics, allowing protocol data to be attained whilst participants both use and create comics in pairs. Due to the limited number of participants, video data are taken of participants using interactive comics instead of heat maps, which allows protocol and usability data to be rapidly correlated. It is argued that this process facilitates the identification of patterns of comprehension, user experience, and desig, which inform potential categories of users and design considerations of interactive stories.

4.6 – Conclusion

In the present chapter, the dilemmas facing researchers of interactive stories have emerged as being consistent with the dilemmas facing theorists of interactive stories discussed in Chapter 2. Interactive stories can be designed to accommodate the input of users in various ways and to various extents, which means that there are a wide range of possible phenomena that can be explored in relation to both the comprehension and user experiences of interactive stories. Nevertheless, commonalities amongst the potential methods have informed an approach that

employs comics to measure responses to interactive stories in this chapter. In combination with the approach to designing interactive stories discussed in Chapter 3, this process has the potential of contributing a comprehensive procedure for designing, visualising and evaluating interactive stories. The use of comics in both the dissemination and evaluation of interactive stories has the potential to limit issues of subjectivity due to the pre-existing visual categories being perceptible and consistent.

The previous work described in the present chapter also illustrates the range of phenomena that can emerge in studies of interactive stories as well as those that are anticipated, particularly with regard to user experiences. This provides evidence that theoretical assumptions of responses to stories and interactive stories may be insufficient for design processes. Therefore, as outlined in Section 4.5.5, the remaining chapters in the thesis explore the application of the theory and evaluation methods proposed, demonstrating how iterations of designs and evaluations can influence the development of interactive stories.

CHAPTER 5: AN EXPLORATION OF COMICS AS VISUALISATIONS OF QUALITATIVE DATA

5.1 – Introduction

The first study in this thesis explores the impact of rearranging panels in a comic upon the recollections of its story. The story structure of the correct panel sequence is loosely based upon the theory of a visual narrative structure proposed by Cohn (2013b). The panels presented to participants depict an attack and a mugging, which takes place outside of a shop. Two groups of students are shown either the correct sequence or incorrect sequence of images and asked to recall what they saw. While the comparison of responses to the sequencing of narrative units is not new (Cohn et al., 2012; Urakami and Krems, 2012), the method employed in this study is designed to gather data related to high and low levels of abstraction in the context of this thesis. The comparison of high level and low level recollections is made by categorising responses according to the visual layout of information contained within the comic and visualising them as heat maps. The purpose of this study is to identify the details that can be contained within recollections related to different levels of abstraction, and how these could inform the information that can be assigned to abstraction levels in design processes. The comparison between different arrangements of panels provides additional data related to the impact different explorations of narrative units could have upon recollections. The findings show that rearranging panels has a limited impact upon high level comprehension, but the different emphases or interpretations of lower level details could inform designs and evaluations of interactive stories.

5.2 – Study

As discussed in Chapter 4, the rearrangement of narrative units in comics and interactive stories has been studied previously (Cohn et al., 2012; Urakami and Krems, 2012). These studies are employed to explore specific phenomena related to story comprehension. A study by Cohn et al. (2012) into comic strips is designed to determine the validity of Cohn's (2013b) visual narrative structure. In their examination of hypertext stories, Urakami and Krems (2012) study the comprehension of causal and temporal relations between events when the sequencing of events is altered. In the present study, the impact of rearranging panels upon recollections according to levels of abstraction is considered.

5.2.1 – Categorisation of Visual Information

The potential application of visualising responses to comics as heat maps as proposed in Chapter 4 is now explored. The argument presented in Chapter 4 states that the visual layout and contents of comics can provide a set of visual categories to which qualitative protocol data can be assigned. To assess this proposal, a visual story is designed and its elements are categorised for the purposes of assigning protocol data to these categories in the present study. Though the design of the sequence is inspired by Cohn's (2013b) visual narrative structure, the categorisation of elements within panels is based purely on the information represented visually. As stated in Chapter 4, while the visual information within comics is fixed, there may be ambiguity in the details, or levels of abstraction, that can be categorised. Therefore, this exercise serves to explore the division of comics into visual units, and how they could correspond with responses.

5.2.2 – Abstraction Levels

Though the use of protocol data in this study is derived from related methods discussed in Chapter 4, these methods have not been previously applied to the study of abstraction levels in interactive stories. There could be many levels of abstraction in the designs of interactive stories, as discussed in Chapters 2 and 3, and data related to these levels could benefit designers by providing insight into the content that users respond to. While it is not explicitly stated, the study by Mandler and Johnson (1977) discussed in Chapter 4 identifies responses that could correspond with levels of abstraction when differentiating between 'summaries' and 'verbatim' recollections of stories. In exploring the potential use of responses to abstraction levels, the present study encourages both summaries and detailed recollections of stories by asking respondents to recall detailed information related to individual panels followed by summaries of the panel sequence presented.

5.2.3 – Comic Design

As described in Chapter 3, Cohn's (2013b) theory of visual narrative structure distinguishes categories of panels that are Establishers, Initials, Prolongations, Peaks, and Releases within comic strips, and is derived from previous approaches to story hierarchies discussed in Chapter 2. For the present study, a short strip with panels corresponding to these categories is presented to participants. The purpose of this is not to validate Cohn's (2013b) theory, but to explore how recollections related to abstraction levels could reflect hierarchies of story content, and inform designs and evaluations of interactive stories. In Chapter 3, Cohn's hierarchies of embedded phases within comics are compared with other story structures, such as story grammars, and applied to levels of abstraction. It is argued that embedded phases could reflect the content explored within interactive stories. The present study therefore explores whether participants

identify details within a sequence that could correspond with hierarchies of story content, and the implications for interactive story designs.

The rearrangement of panels in this study provides a comparison with data related to the correct sequence of panels. Based on the studies by Urakami and Krems (2012) discussed in Chapter 4, it is not anticipated that this rearrangement will have an impact upon comprehension. Also, the rearrangement of narrative units is a characteristic of hypertext stories (Gee, 2001; Mangen, 2008; Urakami and Krems, 2012) that is not reflected in the use of interactive comics proposed in this thesis. However, the results from the present study could indicate the differences that may be seen in recollections related to abstraction levels in studies of interactive comics. As users of interactive comics can be encouraged to explore different possibilities in stories, they can revisit panels or sequences of panels in orders that differ from traditional comics. If this results in different responses, then the present study provides a foundation with which the impact of interactions can be compared.

Figure 5.2.3.1 shows the comic tested in this study. This scene is designed to depict an incident in which a mugging escalates into a violent attack when the victim resists having her bag stolen. The first panel Establishes the scene according to Cohn's (2013b) theory; depicting two men and one woman walking past a shop. The tension of the story's arc is Initialised in the second panel when the man following the woman reaches for her handbag; attracting the attention of both the woman and man in front. The sequence is Prolonged in the third panel when the woman punches her attacker in response to this threat, which alarms the other male. The Peak of the sequence is the fourth panel, where the male assailant attacks the woman and snatches her bag, prompting the remaining male to run back towards the scene. The tension of the arc is Released in the final panel, which shows the assailant escaping with the woman's handbag while the other male reaches down to assist the woman who has been knocked to the ground.

1. ESTABLISHER (4)

2. INITIAL (3)

3. PROLONGATION (1)

4. PEAK (5)

5. RELEASE (2)

Figure 5.2.3.1 - Mugging scene panel sequence according to Cohn's (2013b) visual narrative structure, with the number in the incorrect sequence shown in parentheses

The visual elements within the panels in Figure 5.2.3.1 are designed to be distinctive to limit the possibility of obtaining ambiguous responses. For example, while there are two men in the scene (one witness and one assailant) they are wearing different coloured clothes, have different coloured skin, and are positioned at opposing sides of the panels. In addition, the characters' actions in the comic are visualised according to McCloud's (2006) and Eisner's (2008a) recommendations for illustrating behaviours. These methods are employed in traditional comics, and potentially useful for collecting and analysing data where respondents are asked to distinguish between narrative elements that are presented visually.

In Figure 5.2.3.1, the numbers in parentheses show each panel's position within the incorrect sequence when presented to participants. This order is chosen based upon the potential ambiguity of the individual panels and the reclassification that could occur through their rearrangement. As stated in Chapter 3, the embedding of visual elements at low levels of abstraction in interactive comics could impact the categorisation of panels at upper levels, which may impact readings. By rearranging panels, the change in sequence could also affect their categorisation, the results of which can be compared with studies of interactive comics. In the same way that McCloud's (1993, p. 105) branching comic discussed in Chapter 3 exploits mental and situation models to manipulate the meanings of panels based upon the direction(s) in which they are read, the ambiguity of events depicted in individual panels in the present study could affect the responses. The first panel shown in the incorrect sequence, for example, shows the victim striking her assailant. In the context of the surrounding panels, this has been classified as a Prolongation panel in the design phase. However, when shown in the incorrect sequence, this could be seen as a self-contained incident or Peak before its meaning is situated within the context of the remaining panels. It is anticipated that users will comprehend the temporal and causal links between panels once the entire sequence is summarised, following

the work of Urakami and Krems (2012) and Cohn et al. (2012) discussed in Chapter 4. The incorrect sequence is designed to explore whether responses at low levels of abstraction, which in this case relate to individual panels as they are presented, affects the recollection of narrative elements and how panels are interpreted and/or classified. This could indicate whether interacting with comics would develop similar effects, and inform future designs and evaluations.

5.2.4 – Panel Categories

Following the proposed method of visualising responses in Chapter 4, Figure 5.2.4.1 shows how panels are divided into sections based upon the characters, setting, actions, and levels of detail in the present study. The character shapes are subdivided into their distinguishing characteristics in the original comic, such as skin colour, and objects, such as clothing or accessories (the woman's hand bag). Containers housing arrows adjacent to characters are designed to depict corresponding actions.

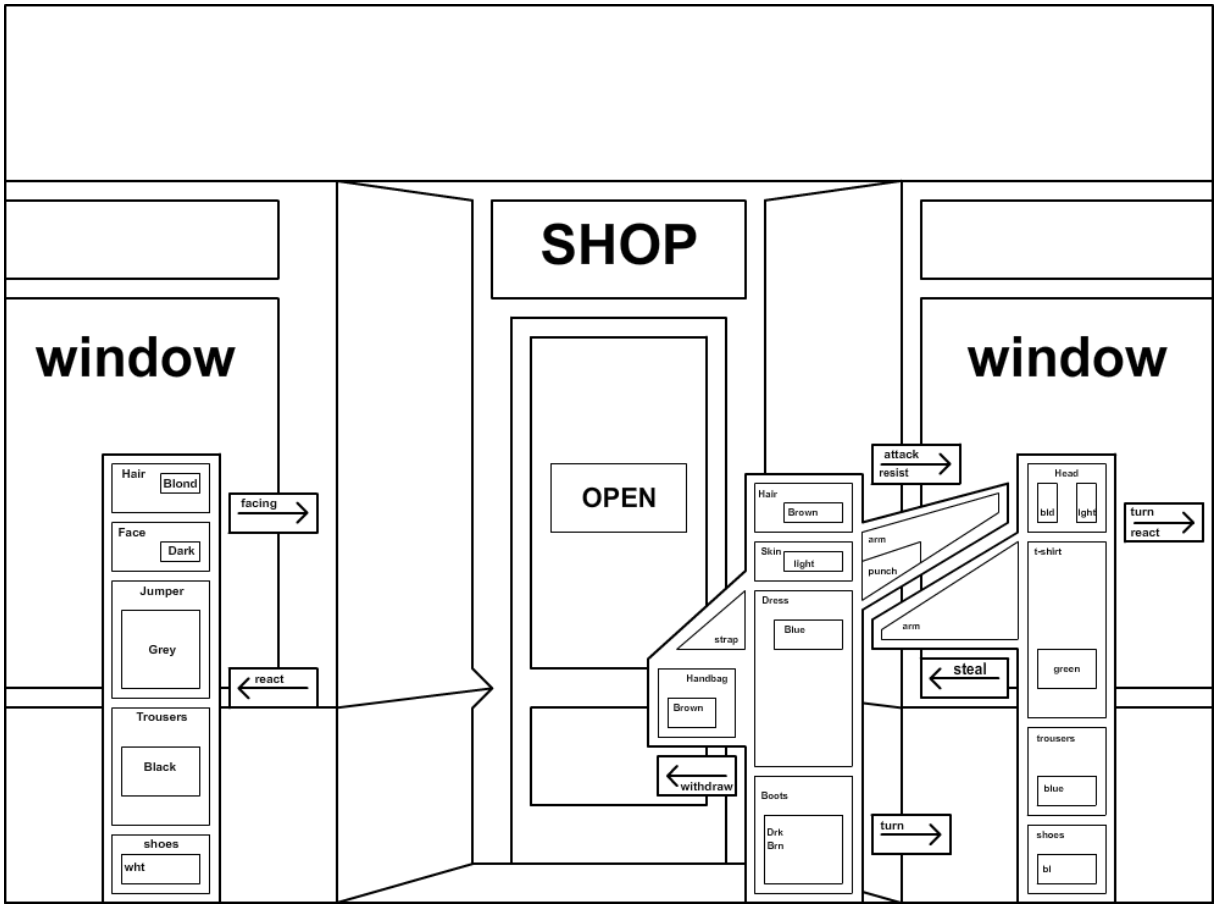


Figure 5.2.4.1 - Diagrammatic representation of the Prolongation panel

5.2.5 – Method

For this pilot study, two groups of five undergraduate students aged between 18 and 20 are recruited. The panels are presented individually in front of each group via an overhead projector for 1 minute at a time, after which participants are given several minutes to provide written descriptions of what they thought was happening before the next panel is presented. Both groups are told in advance whether the panels are presented in the correct or incorrect order, though the order of the incorrect sequence is not specified. In the present study, participants are asked to describe panels after they have been shown to them individually in order to facilitate the gathering of data that can be related to low levels of abstraction. Once all the slides are

shown, participants are asked to provide a written summary of the sequence's story, which can be related to high level(s) of abstraction. Data are collected in the form of written recollections, and categorised according to the representations of the panels as described in Section 5.2.4. Responses are then quantified and represented as heat maps within the diagrammatic representations of the panels.

For summary statements, limited amounts of detail are visualised when information can be inferred from responses. For example, in one summary a participant writes: "Unfortunately the [assailant] at the back tried to rob [the victim's] bag. She resisted the robber while the [witness] in front came to the rescue. It was too late. The robber got away." Vague terms such as 'robber' or phrases such as "got away" and "came to the rescue" are assigned to containers that are most reflective of the respective actions within corresponding panels, based upon their context.

5.3 – Results

5.3.1 – Visualisations

The visualisations produced from assigning responses as heat maps to the layout of the comics can be seen in Figure 5.3.1.1 and Figure 5.3.1.2. Figure 5.3.1.1 illustrates the visualisations of responses to individual panels, while Figure 5.3.1.2 represents the summaries given. The left hand columns of images in each of these figures represents the responses to the correct sequence of panels, while the columns to the right represent responses to the incorrect sequence. The visualisations show that readers of both the correct and incorrect sequence of panels use similar details in their written descriptions of both individual panels and summaries. Yet, there are subtle differences that could be used to inform further designs, visualisations and evaluations.

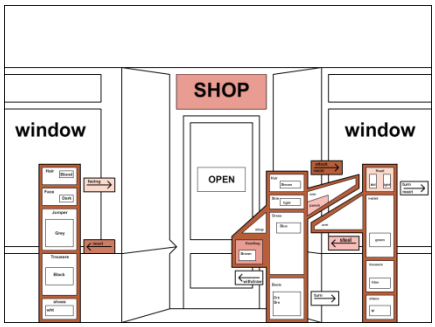
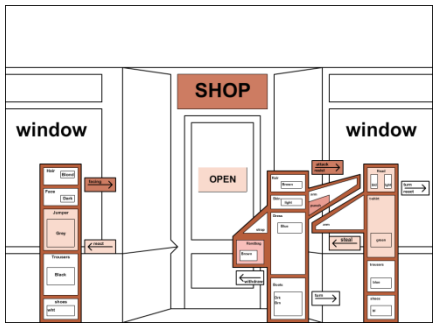
PANEL	CORRECT SEQUENCE	INCORRECT SEQUENCE
ESTABLISHER **(4th in incorrect sequence)**		
INITIAL **(3rd in incorrect sequence)**		
PROLONGATION **(1st in incorrect sequence)**		
PEAK **(5th in incorrect sequence)**		
RELEASE **(2nd in incorrect sequence)**		

Figure 5.3.1.1 - Visualisations of written descriptions of individual panels

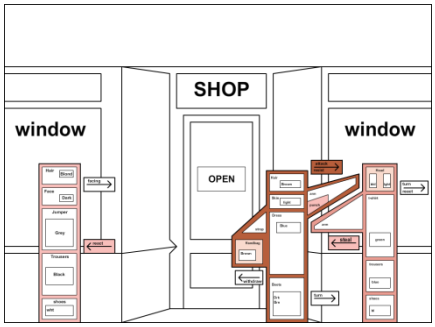
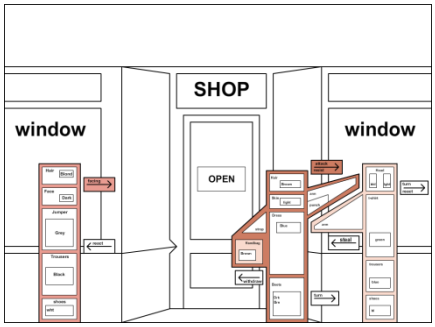
PANEL	CORRECT SEQUENCE	INCORRECT SEQUENCE
ESTABLISHER (4th in incorrect sequence)		
INITIAL (3rd in incorrect sequence)		
PROLONGATION (1st in incorrect sequence)		
PEAK (5th in incorrect sequence)		
RELEASE (2nd in incorrect sequence)		

Figure 5.3.1.2 - Visualisations of written summaries of the panel sequence

5.3.2 – Establisher Panel

All respondents identify that two males and one female are walking past a shop in the Establisher panel. One participant summarising the correct sequence of panels uses the visual characteristics of the characters in their description: “The women is wearing a blue dress and one man is wearing a green t-shirt has a bald head”. The remaining summaries distinguish characters in this panel by their gender (male or female) action (walking) and proximity to each other and/or the shop, rather than any of their features. The only other exception can be seen in references to the woman’s bag, which is mentioned in the summaries of both the correct and incorrect sequences, and in individual panel descriptions of the incorrectly sequenced Establisher.

From the visual representations of the descriptions of the individual panels, there are minor differences between the panels shown in the correct or incorrect order. As well as noting the bag in the incorrectly sequenced panels, another participant describes what the assailant is wearing in the Establisher Panel, and describes him as ‘following’ the woman. In the correctly sequenced panels, a participant also uses the term ‘following’ to describe the behaviour of the assailant.

5.3.3 – Initial Panel

All the respondents’ descriptions of the individual Initial panel in the correctly and incorrectly ordered sequences identify that the assailant makes an attempt on the victim’s hand bag. The summaries also show that participants of both sequences identify this as being a significant event. Three participants describe the reaction of the victim in the summaries, but only one participant describes the reaction of the witness at this point; in the correct sequence. Additional details about the witness are provided in the individual panel descriptions. One participant

describing the panel in the correct sequence writes “Male in front is assessing situation”. Another participant describing the panel in the incorrect sequence writes “another man is standing to watch without bothering to help”. The remaining participants’ descriptions relate only to the basic actions being portrayed rather than the intentions these actions may indicate, such as “Another man is walking in front who also looks back”.

5.3.4 – Prolongation Panel

The visualisations portray that the descriptions of the prolongation panel in the correct and incorrect sequences are similar in terms of the details identified. All of the respondents note the three characters in the scene, and that the woman was striking one of the men. There are differences depicted in the visualisation with regard to the behaviours of the witness and the assailant. In the correct sequence, respondents record that the witness is reacting to the actions of the other two characters, such as “the other male is trying to calm things down”, whereas those recalling the panel in the incorrect sequence provide simple descriptions of the character’s actions, such as “There is another person watching”. There are no differences in the descriptions of the victim and the assailant in this panel. One participant references the victim’s bag and the attempt by the assailant to steal it in the correct sequence. This inference is also identified by a participant describing the panel in the incorrect sequence (“It looks like the man is going for the woman’s purse”). One participant recalling this panel in the correct sequence states “the lady tried to resist one of the men who tried to rob her bag”, whilst from the incorrect sequence one participant writes “Woman punching man also holding onto her bag”.

5.3.5 – Peak Panel

The visualisation shows that the details used in the Peak panel are similar in recollections of both the correctly and incorrectly sequenced panels. The descriptions of the theft of the bag and

the witness approaching are consistent amongst participants viewing the sequence in the correct order. One participant viewing the incorrect sequence shows a lack of confidence in their interpretation: “I think the man is trying to steal the woman’s bag”. Another participant viewing the incorrect sequence does not refer to the bag at all: “The man and woman are in a fight and the man in white runs to try and break it up”. However, the visualisations show that more participants viewing the incorrect sequence recount the theft at this point than those viewing the correct sequence in their summaries. Accounts of the witness are consistent across all descriptions.

5.3.6 – Release Panel

Accounts of the release panel are consistent with all the respondents who view both the correct and incorrect sequences; identifying that the assailant is running away with the victim’s bag, and that the victim is on the floor, having either been hurt or knocked down. None of the respondents specify that the assailant has knocked down the victim in the individual descriptions. All but two of the respondents state that the witness is helping the victim here. Two respondents state that the witness is holding down the victim in their description of this panel; one having viewed it in the correct sequence and the other having viewed it in the incorrect sequence. The respondent who viewed the sequence in the incorrect order states in their summary that the witness is a thief, as discussed in Section 5.3.7.

5.3.7 – Summaries

The visualisations show that participants omitted details in their summaries rather than identified different ones, with the exception of one participant who identified the shop window in their summary having viewed the correct sequence. One of the participants states “This scenario is about two thieves that stole a woman’s hand bag in front of a shop, and the woman

tries to take her bag back by holding down one of the men", when summarising the incorrect sequence of panels. This is the only participant to identify the witness as being a thief in the summary, or that the resistance occurs after the bag was stolen. As the model for visualising the readings is designed to represent the levels of abstraction rather than the different meanings, it does not accommodate this anomaly. This is the only summary where the meaning of the sequence of panels could be said to deviate from the story designed. However, the visualisations of the summaries show that the differences in the recollections of the witness' actions and behaviour carry over from the individual descriptions of the Prolongation panel, with participants giving details of a *reaction* in summaries of the correct sequence, as opposed to those that describe an *action* in the summaries of the correct sequence. In the incorrect sequence, all participants describe details of the struggle in the Peak panel in their summary, which is one more than those describing it in the incorrect sequence. By contrast, all of the participants who view the correct sequence describe the struggle in the Prolongation panel, which is one more than those viewing it in the incorrect sequence.

5.4 – Discussion

The similarity in the visualisations indicates that the rearrangement of panels has little bearing upon the recollections. This is predominantly the case, though there are recollections from respondents that state the sequence involves a conflict with two assailants, which may be affected by the ambiguity of the artwork and the rearrangement of the panels. As discussed in Chapters 3 and 4, ambiguous artwork could be employed to portray different abstractions visually in interactive stories. Yet, in spite of the ambiguity of the illustrations, it was not anticipated during the design of this sequence that the role of the witness could be misconstrued. One participant recalls this detail in both the panel descriptions and summary of the sequence.

Another participant makes the same identification during their low level descriptions but omits this detail at a high level. There are also differences in descriptions of this character's behaviour during low level panel accounts, reflecting the unclear motives of this character, at least until the story is finished. From a design perspective, these responses could be used to inform the creation of an interactive story in which the role of this character can be changed at a low level of abstraction. However, this insight cannot be obtained from the data visualisations. The same could be said of representations of readings that show a lack of confidence in their interpretations, an example of which can be seen in a response to the Peak panel shown in the incorrect sequence. Therefore, while abstractions of illustrations can encourage different interpretations of story content, it could be that these visualisations of data are more suitable for depicting the different visual details that respondents identify.

The heat maps provide insight into the kinds of details that could be embedded in future visualisations and abstraction levels of an interactive story. Whilst there are multiple containers in the visualisations to accommodate fine levels of detail, such details are rarely referenced by participants. Differences can be seen in both descriptions of panels and summaries related to actions of the assailant and the victim during the struggle depicted in the Prolongation and Peak panels. These correlate with references to the bag, which is to be expected given the importance of this object in relation to the motivation for the struggle in the design of the comic. The differences in the visualisations therefore help define the different levels of abstraction to which details could be assigned in this case: at a high level a struggle ensued, and at a low level it was because someone was trying to steal someone else's handbag. This is also reflected in the number of participants that refer to the corresponding panels in the summaries. While the Peak panel is designed to be the height of the narrative tension, both the Prolongation and the Peak are referenced by participants within their summaries. It was anticipated that respondents

viewing the panels in the incorrect sequence may emphasise the victim's retaliation in the Prolongation panel more than those viewing the sequence in the correct order, as discussed in Section 5.2.3. Interestingly, however, more respondents viewing the sequence in the correct order identify the struggle in the Prolongation panel than the Peak, while the reverse is true for those viewing the sequence in the incorrect order. While this may be due to the ordering of panels (the Peak was the last panel to be viewed in the incorrect sequence) it could also reflect the ambiguity of the struggle, which is consistent with the other data. From a design perspective, therefore, these results indicate that both the Prolongation and Peak panels reflect a struggle, which would be the top of the hierarchy of abstraction. At lower levels, the individual panels depict actions, objects and the sequence of events that lead to this struggle, which could be changed within the interactive version of this story.

5.5 – Conclusion

The separation of data into details and summaries provides insight into both comprehension and the possibilities for interactive story designs to be informed by responses. Comparing accounts related to high and low levels helps categorise story content according to levels of abstraction, even when content has previously been assigned. During the design of the comic for this study, for example, it was not anticipated that the actions of the witness would have a range of interpretations, or that the struggle in the Prolongation panel would be emphasised by the group viewing the sequence in the correct order. Following the exploration of related methods in Chapter 4, these findings provide evidence that it may be inappropriate for creators to depend upon their designs to anticipate responses to stories, which could also be true of interactive stories.

Visualisations of these data facilitate the identification of these patterns, but there are limitations in their current form. Firstly, the categories of visual information are inappropriately detailed for the responses. Secondly, the visualisations are unable to reflect interpretations of characters' roles or behaviours. The focus upon the comic's visual content in the visualisations therefore reflects the potential limitation of the focus upon content in the approach to designing interactive stories in this thesis, as discussed in Chapter 3.

However, these limitations could be overcome with continued developments. For example, instead of subdividing containers according to specific visual information, subdivisions could correlate with different possibilities in interactive stories. These possibilities could be designed or, as is the case with the present study, emerge through responses. Although it could be argued that this could give rise to the problem of subjectivity, as discussed in Chapter 4, the categorisation would still occur within a fixed, visual framework, which the present study shows is beneficial for identifying elements of comics that users respond to. In addition, comics can integrate text with images as discussed in Chapter 3, which can be used to clarify or contain information related to different possibilities at low levels of abstraction. Finally, the results of the visualisations can be correlated with debriefing sessions or additional protocol data to explore the reasons behind the focus upon specific narrative content. Consequently, the thesis now turns to the design, visualisation and evaluation of an interactive, branching comic to explore the impact of interactions upon recollections of levels of abstraction, how the process of visualising responses can be refined, and how debriefing sessions can be conducted to complement these visualisations.

CHAPTER 6: A STUDY INTO THE DESIGN AND EVALUATION OF AN INTERACTIVE, BRANCHING COMIC

6.1 – Introduction

The present study explores the potential impact that interactivity could have upon the reading experience of comics. The purpose of this study is to explore the application of the design process for interactive branching comics described in Chapter 3 and the potential methods for evaluating comics explored in Chapters 4 and 5. As shown in Chapter 5, data can be obtained from responses to comics related to comprehension that could inform designs of interactive stories. The present study therefore refines these methods to investigate whether similar insights can be obtained from evaluating interactive comics.

The comic in this study is designed to have a self-contained story at a high level of abstraction, with the comic's branches created by embellishing the narrative through additional images and text. The interactive comic is tested against a non-interactive version of the same comic in which all the branches are presented to users on paper. Visualisations are employed, developed from those proposed in Chapter 4 and used in Chapter 5, in order to explore whether responses to the comic correspond with its design, and the impact of incorporating interactivity within a branching comic. The heat maps in these visualisations reveal a range of differences between the branching comic presented in interactive, digital form and non-interactive form on paper. Following observations made during the experiment, debriefing sessions with participants are conducted, which provide additional insight into the data visualisations and experiences of using the comics.

6.2 – Study

Chapters 2 and 3 of the thesis inform an approach to designing and visualising interactive stories using branching comics, which is applied in the present study. The methods explored in Chapter 4 and the findings from Chapter 5 show that qualitative responses to sequences of panels could be used to inform the designs of interactive stories. The study from Chapter 5 shows both benefits and limitations in the application of heat maps to visualise responses. In the present study, the method of categorising and visualising responses is refined to reflect the content of interactive stories, and applied to evaluate the interactive comic designed. Following some methods discussed in Chapter 4, additional protocol data is obtained to complement the visualisations and counter any limitations that may result from the exclusive use of a single method of representing data.

6.2.1 – Comic Design

For the present study, a short comic of two pages is created, containing several branch points, which can be presented in interactive, digital form and in printed comic book form. In the printed comic book, the branches are presented as various versions of the same story, shown in multiple two-page 'spreads'. The digital version presents these two pages on computer screens and the text and artwork within them are embellished through interactions. As part of a local project exploring attitudes in aviation travel, the design of the comic is based upon the concept of a father of two children travelling from the Midlands in the UK to visit his sister in Chicago in the U.S. One of the children can accompany him, and they have to decide which case to take, which airport to fly from, how to travel from the airport in Chicago, and which sights to see once they're in Chicago.

Following the approach discussed in Chapter 3 and Eisner's (2008a, p. 131) comic strip from Table 3.4.1.1, the top level of the comic is designed to present a story purely through visual material, and contains all the visual elements to be contained within the story before any branching occurs. This can be seen in Figure 6.2.1.1, which also shows the potential Establisher and Release panels that could be interpreted from this layout according to Cohn's (2013b) theory of visual narrative structure. The first panel in this image establishes the scene; a family sitting on a settee together. The final panel shows the man in this family waving goodbye to his sister. The remaining panels are designed to depict this man's journey and the events at a high level of abstraction to accommodate further changes to the narrative(s) at lower levels.

Figure 6.2.1.1 - The design of the top level of abstraction in the branching comic, with potential Establisher and Release panels highlighted

Following the discussions of comics in Chapter 3 and the findings from Chapter 5, the second level of abstraction integrates text within the panels to define a coherent story, which can be seen in Figure 6.2.1.2. This text is delivered through captions across three panels in the comic describing basic details about the trip: “The Friendly Family Father, Fred, is going to visit his sister in Chicago. After a long flight, Fran met them at Chicago O’Hare Airport. They had a good trip… could it have gone differently?” These could be termed ‘inevitable events’ according to discussions in Chapters 2 and 3, meaning that this level would not emerge through interactions. The addition of this narrative material is designed to prevent the misinterpretation of the roles of characters, in response to observations made in Chapter 5. This also provides structure to the story; the panel groups of which could correspond with those of Cohn (2013b).

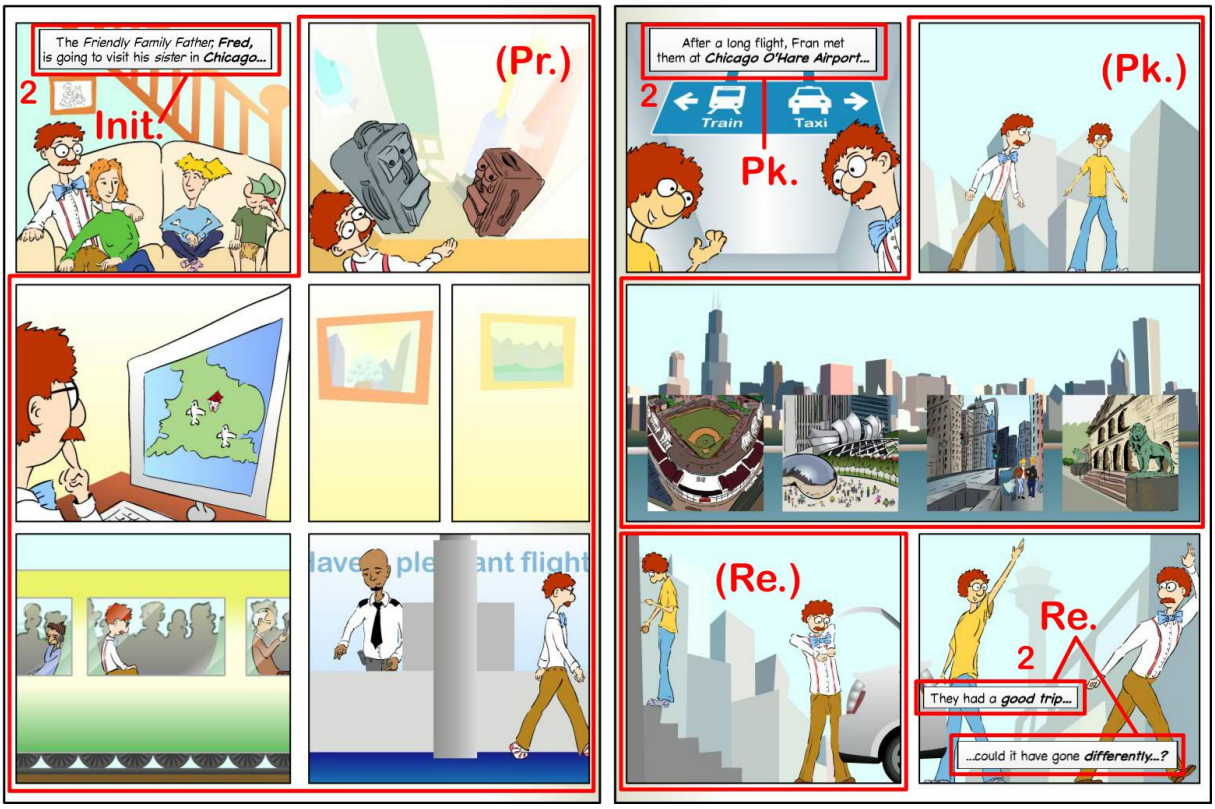


Figure 6.2.1.2 - Integrating captions in the branching comic to define the second level of abstraction and potential panel groups of Initials, Prolongations, Peaks and Releases

The third level of abstraction in the comic is conceived as providing information regarding the possible options available to the family. As shown in Figure 6.2.1.3, these are depicted as captions, dialogue bubbles and 'hot spots' that are prompts to the user to make decisions within the interactive comic. These could correlate with Episodes in Thorndyke's (1977) story grammar hierarchy as discussed in Chapter 2, or embedded Phases in Cohn's (2013b) visual narrative structure. Whilst a coherent narrative can still be derived from this level, the outcome of these decisions leads to the lowest level of abstraction, which the user can influence in the interactive comic. An example of one narrative that is formed through this process can be seen Figure 6.2.1.4, which demonstrates how the upper levels of abstraction can be embellished with additional images and text to reflect the different choices.

Figure 6.2.1.3 - The branching comic at a level of abstraction where decisions are made and options can be explored (asterisks represent 'hot spots' in the interactive comic)

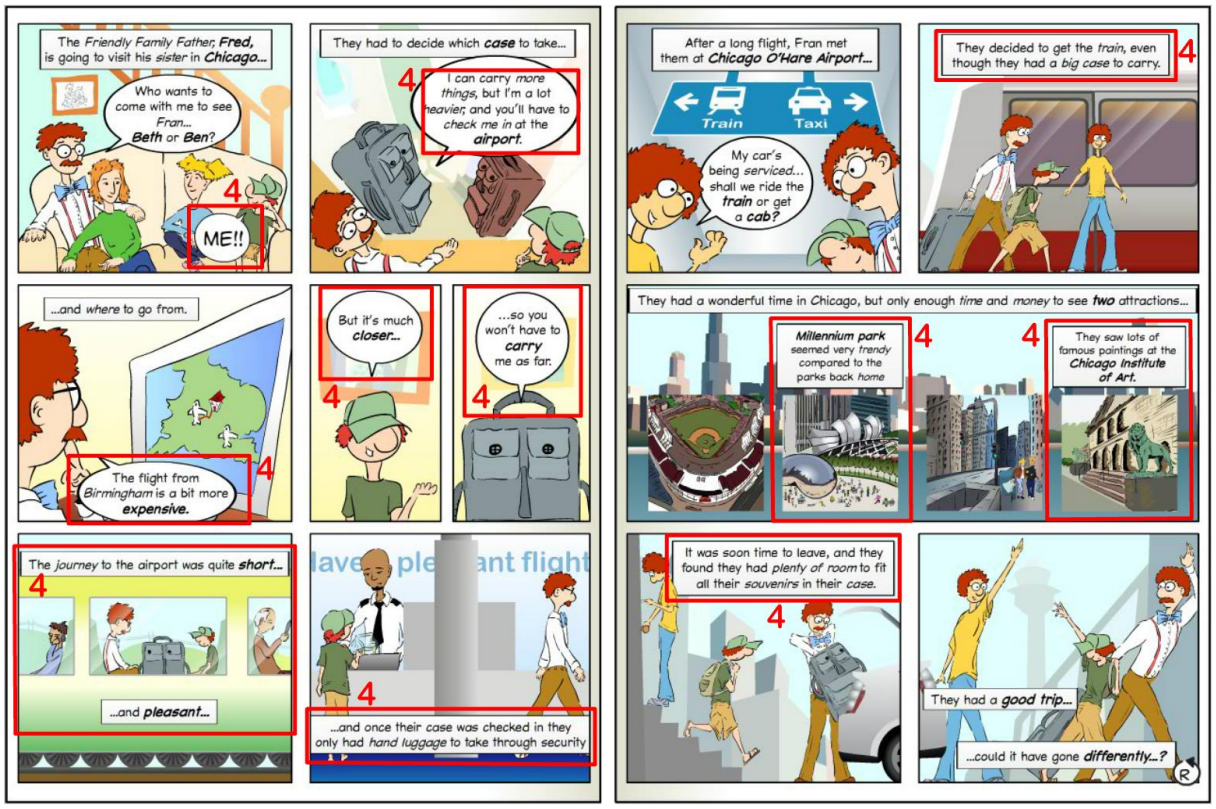


Figure 6.2.1.4 - An example of the comic at its lowest level of abstraction

In the example shown in Figure 6.2.1.4, the decision to fly from Birmingham, which is more convenient but more expensive, means that the family cannot afford to see more than two attractions whilst in Chicago. Had they flown from London, the flight would have been cheaper and they would have been able to see more attractions, but the journey over would have been longer and less pleasant. If they had taken the taxi from Chicago O'Hare, they would have had a more pleasant trip but spent even more money, so would only have been able to see one attraction. The decision to carry a big case means the family can take more liquids and bring back more souvenirs, but the case is more difficult to carry around depending on the modes of transport chosen. In the end, regardless of the decisions made, the family always has a good time. With reference to Table 3.4.2.1 in Chapter 3, Table 6.2.1.1 shows how different variables can lead to this outcome within the hierarchy of abstractions in the comic.

<table>
<tr><td>ABSTRACTION</td><td colspan="10">CONTENT</td></tr>
<tr><td>HIGH LEVEL</td><td colspan="10">IMAGES (STORY)</td></tr>
<tr><td rowspan="2">LEVEL 2</td><td colspan="10">CAPTIONS (INEVITABLE EVENTS)</td></tr>
<tr><td colspan="3">The Friendly Family Father, Fred, is going to visit his sister in Chicago…</td><td colspan="3">After a long flight, Fran met them at Chicago O’Hare Airport…</td><td colspan="4">They had a good trip… Could it have gone differently…?</td></tr>
<tr><td rowspan="2">LEVEL 3</td><td colspan="10">CAPTIONS AND DIALOGUE (DECISION POINTS / PHASES / EPISODES)</td></tr>
<tr><td colspan="2">Who wants to come with me to see Fran… Beth or Ben?</td><td colspan="3">They had to decide which case to take…</td><td colspan="2">…and where to go from.</td><td colspan="2">My car’s being serviced… Shall we ride the train or get a cab?</td><td colspan="2">They had a wonderful time in Chicago, but only enough time and money to see two attractions…</td></tr>
<tr><td rowspan="2">LOW LEVEL</td><td colspan="10">IMAGES, CAPTIONS AND DIALOGUE (NARRATIVES)</td></tr>
<tr><td>Ben goes</td><td>They take a Big Case</td><td>They fly from Birmingham</td><td>It’s expensive but closer</td><td>So they won’t have to carry the case far</td><td>The journey was short and pleasant</td><td>They checked their case in at the airport</td><td>They got a train at Chicago, even though they had a big case</td><td>They saw Millennium Park and the Chicago Institute of Art</td><td>They had plenty of room in their case for souvenirs</td></tr>
</table>

Table 6.2.1.1 - The elements of the branching comic and their corresponding levels of abstraction

The story contains enough branches to accommodate sixteen possible variations, including the number of attractions that can be seen but not the different combinations of attractions that can be chosen. This provides a sufficient number of branches for the story to be presented on paper in comic book form, and each variation of the story is presented on an A4 sheet of paper in the comic book. The interactive, digital comic is presented in Adobe Flash, and can be exhibited on both desktop computers controlled with a mouse and mobile tablets controlled with touch input technology. In this format, the user can see the top level of abstraction in the comic's pages from the outset, and the lower level contents are presented sequentially to the user following each of their interactions. Animated hot spots are used to show that the user can make decisions that impact the subsequent panels, and content that leads into the subsequent branch points is presented to the user following each interaction. For example, after the user selects one of the children to go with their father in the first panel, the second panel's caption displays and the cases start flashing, prompting the user to select one to continue the comic. Some choices embellish all the remaining panels with artwork if they impact the comic throughout the story. For example, after choosing either one of the children in the first panel, the corresponding character is shown in the rest of the comic. Previous options can be revisited in the comic and their outcomes explored either before or after the interactive comic is finished. Alternatively, a small reset button displays in the bottom right corner once the comic is finished, which is used to start from the beginning and attempt a new combination. Following discussions of related methods of evaluating interactive stories in Chapter 4, the study is exploratory rather than task-based. Therefore, there are no preferred outcomes in the design of the comic's story.

6.2.2 – Panel Categories

In accordance with the findings of Chapter 5, categories of the comic are created according to the story's branching and narrative content rather than its specific visual details. The comic is

then divided into these categories to provide a visualisation upon which heat maps of the protocol data can be overlaid. The resulting layout can be seen in Figure 6.2.2.1. To represent the hierarchy of different possibilities in the branching comic, sections within the diagram are subdivided according to the different narrative elements that could be shown following each option in the story. For example, if a Big Case and London airport are chosen in panels two and three, then in panel five of page one the Big Case, which is an anthropomorphic character in the comic, points out how inconvenient it might be to carry it such a long way. As this is one of four possibilities that might display in this panel, it is rendered as a small container within the illustration of the dialogue balloon as 'Ldn/ BgC' (London / Big Case).

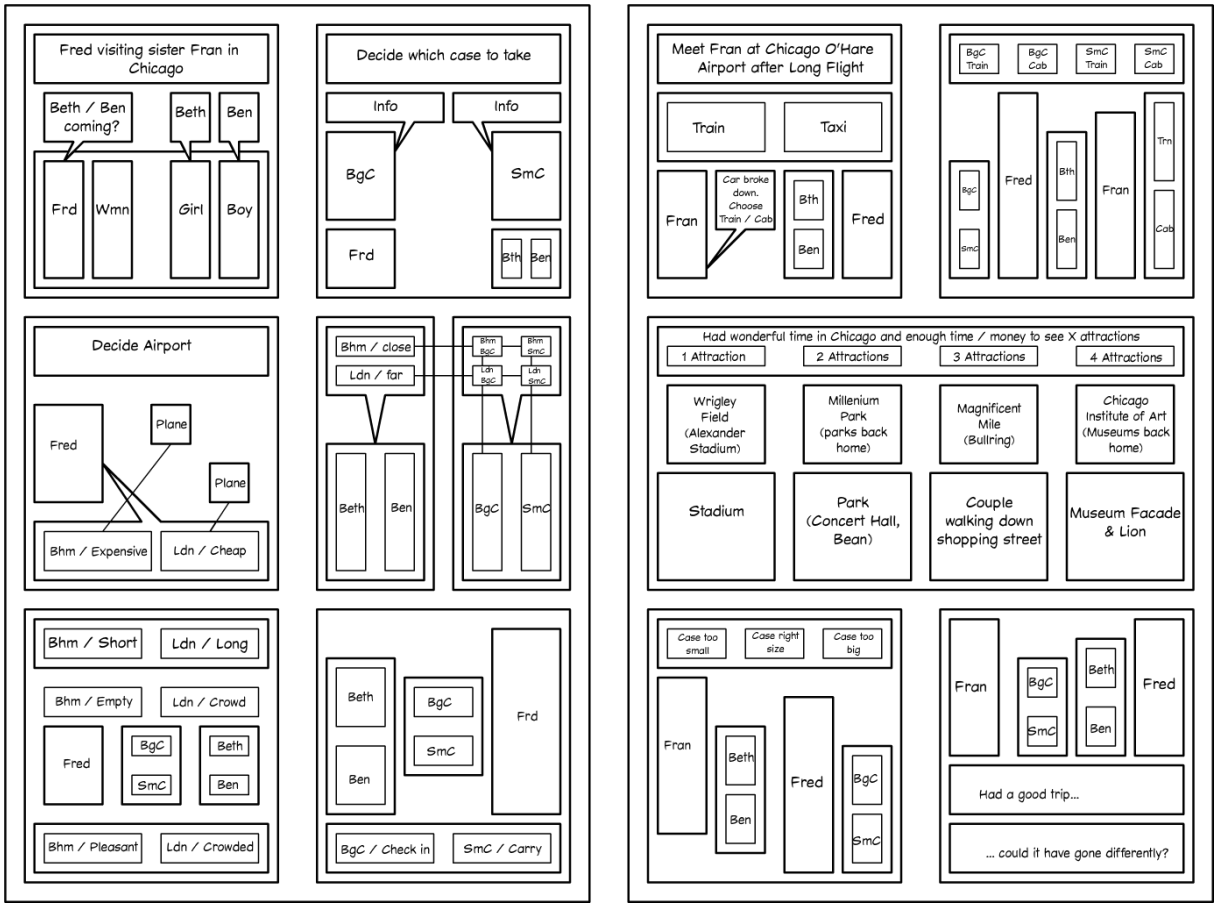


Figure 6.2.2.1 - Diagrammatic representation of the branching comic

6.2.3 – Method

In accordance with the requirements of the project, the comic is designed for children aged between eleven and twelve years old, which is the first year of secondary schooling in the UK. Studies are conducted at an independent boys' school in Birmingham, with two classes of sixteen pupils consisting of this age range. Though narrowing the study to a specific gender and age group creates an obvious limitation, the benefit of using this approach is that it limits the number of variables to be considered in a comparative study, meaning any differences are more likely to be due to the differences in the media rather than the respondents.

The experiment is done in a school computer lab during one of each class' lesson periods. Each class is divided into two groups of eight: one group to read the printed comic on paper and the other to use the interactive comic on a desktop computer. Before beginning the experiment, the pupils are explicitly informed that what they are doing is not a test, that they are not being judged on any perceived measure of performance, and that they should stop reading or using the comics at any point they wish. This is done due to the age of the participants, to discourage students from referring to one another's answers, and to assert that the nature of the study is not task-oriented.

All the pupils are initially shown the paper copy of the comic to demonstrate that each piece of paper actually presents two pages of the comic side-by-side in order to avoid any confusion about the reading direction. It is also explained to them that the comic is actually the same story told slightly differently, and the pages of the comic are turned in front of everybody to portray this. This is deemed necessary due to the time constraints of the experiment, as it may take children a while to understand this of their own accord. The pupils are also informed that the digital version of the comic presents the two pages side by side on the computer screen.

The pupils are given approximately ten minutes to use the digital version of the comic and read the paper version. Those using the desktop version of the comic do not have access to the paper version, and vice versa. Due to the classroom settings in which the study is conducted, a simple questionnaire is adopted to obtain protocol data, which contains two open-ended questions:

1) If you were to summarise the story to someone else, even taking into account its different versions, how might you describe it?
2) How might you describe your favourite version of this story to someone else?

These questions are deemed to be the simplest way of encouraging pupils to distinguish between what could be interpreted as high level overviews of the story and low level specific narratives following the approach in Chapter 5. Prior to the experiment, these questions are briefly explained to the classes. Again, this is deemed to be an important step to take given the time constraints and the participating age group, as 'version' of the story could easily be misinterpreted as referring to the format of presentation of the comic. It is also pointed out that, if the respondents do not have a 'favourite' version of the story, then they could just describe one that they remember.

After completing the questionnaire, the participants are invited to use the alternative version of the comic for the same period of time, without filling out a questionnaire afterwards. During the study, observations are made to inform debriefing sessions where the pupils' reading experiences are briefly discussed, which are methods derived from previous approaches explored in Chapter 4 (Gee, 2001; Poels et al., 2007; Mitchell and McGee, 2011). The only question employed for these discussions is: Which is your favourite format of the comic, and why? The reason this question is integrated into a verbal study rather than a questionnaire is so that details could be clarified and follow-up questions could also be integrated based on the answers to these questions and observations made when the pupils are reading the comics.

Audio recordings of the discussions are made and notes are taken in response to some questions, such as the numbers of respondents who agreed or disagreed with certain statements.

Following the experiments, the responses from the questionnaires are categorised, quantified and represented as heat maps in accordance with the explorations in Chapters 4 and 5 and the Layout in Figure 6.2.2.1. The data from the observations and debriefings are categorised following the analysis of data from the questionnaires. Whilst the implemented question in the debriefings relates solely to respondents' opinions about the different formats of the comic, answers to questions that emerge from observations are also obtained. The categories that relate to the respondents' experiences can then be compared with their responses to the questionnaires. Apart from exploring the reasons behind respondents' opinions about the comics, this approach has the potential to give further insight into the reasons behind any differences in the readings of the comics, if there are any.

6.3 – Results

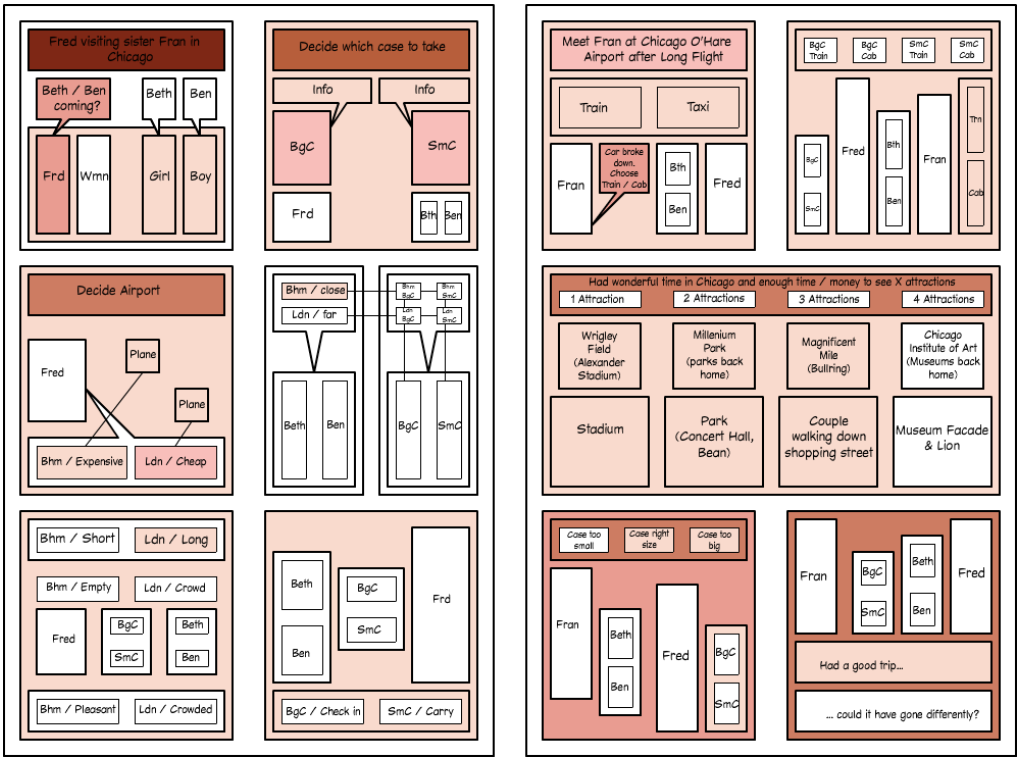
6.3.1 – Questionnaires

In contrast with some of the results from Chapter 5, when analysing the responses to the questionnaires in the present study, statements can be easily visualised within the diagram in Figure 6.2.2.1, as the information respondents provide is a direct reference to information contained in sections of the comic. For example, "They had to decide on a case" is a direct reference to the caption in the second panel of page one. More detailed statements are assigned to multiple containers in the visualisation. For example, "They had to choose the closer but more expensive flight from Birmingham or the further away but cheaper flight from London" is a statement that can be mapped to containers from panels three and four of page one within the comic, which provide this information in combination.

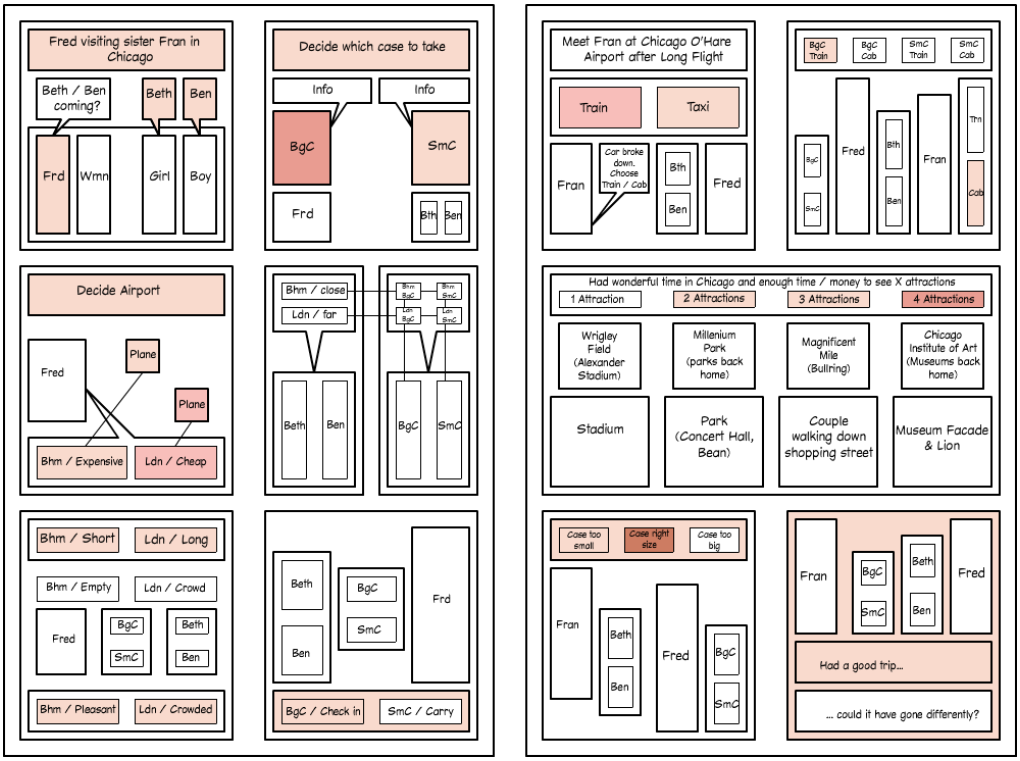
As anticipated, some summary statements are vague and need to be interpreted according to the visual structure of the comic. An example of this is “A family going on holiday to Chicago”. This statement contains information pertaining to both the caption and the image of the family sitting down in the first panel. More ambiguous statements, however, need to be carefully considered when aligning them to the comic diagram. One such statement is “It also tells us about the journey there and back”, in response to the paper comic. When coming across sentences like this, the order in which the information is given is considered during the interpretation. This sentence, for example, comes after the description of having to choose the case and airport, but before the description of choosing sites at Chicago. It is therefore assigned to the group of panels that represents the journey to the airport and the panel depicting the journey from the airport. Though this method could be regarded as limited due to the subjective interpretation of the data, mapping the structure of responses against the visual structure of the comic helps maintain consistency in the interpretations, as discussed in Chapter 4.

Figure 6.3.1.1 shows the visualisations of responses to the paper comic related to both high level (summaries) and low level (‘favourite’) responses. The heat map of high level responses is shown at the top of the figure, and the heat map of low level responses is at the bottom. Figure 6.3.1.2 shows the equivalent visualisations for the digital comic. Unlike the results from Chapter 5, an initial inspection of the heat maps in these visualisations reveals distinct differences in the numbers and distributions of responses according to the formats of the comic and the related levels of abstraction.

PAPER COMIC SUMMARIES / HIGH LEVEL RESPONSES



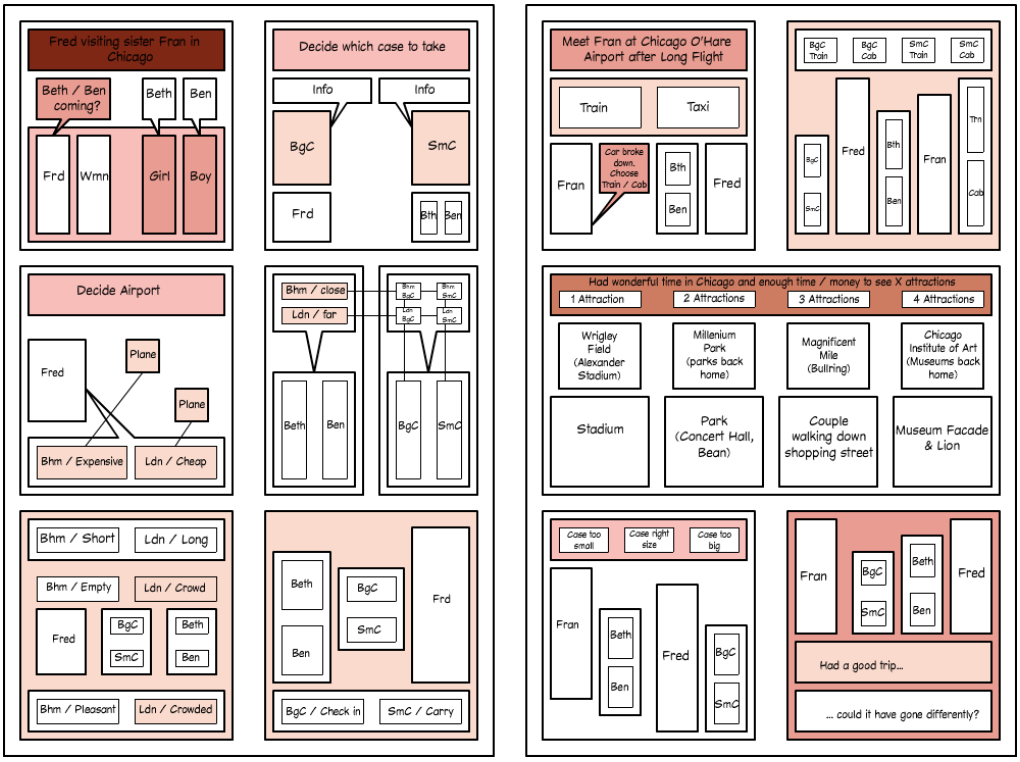
PAPER COMIC 'FAVOURITES' / LOW LEVEL RESPONSES



0 **1-2** **3-4** **5-6** **7-8** **9-10** **11-12** **13-14** **15-16**

Figure 6.3.1.1 - Visualisations of responses to the paper comic

DIGITAL COMIC SUMMARIES / HIGH LEVEL RESPONSES



DIGITAL COMIC 'FAVOURITES' / LOW LEVEL RESPONSES

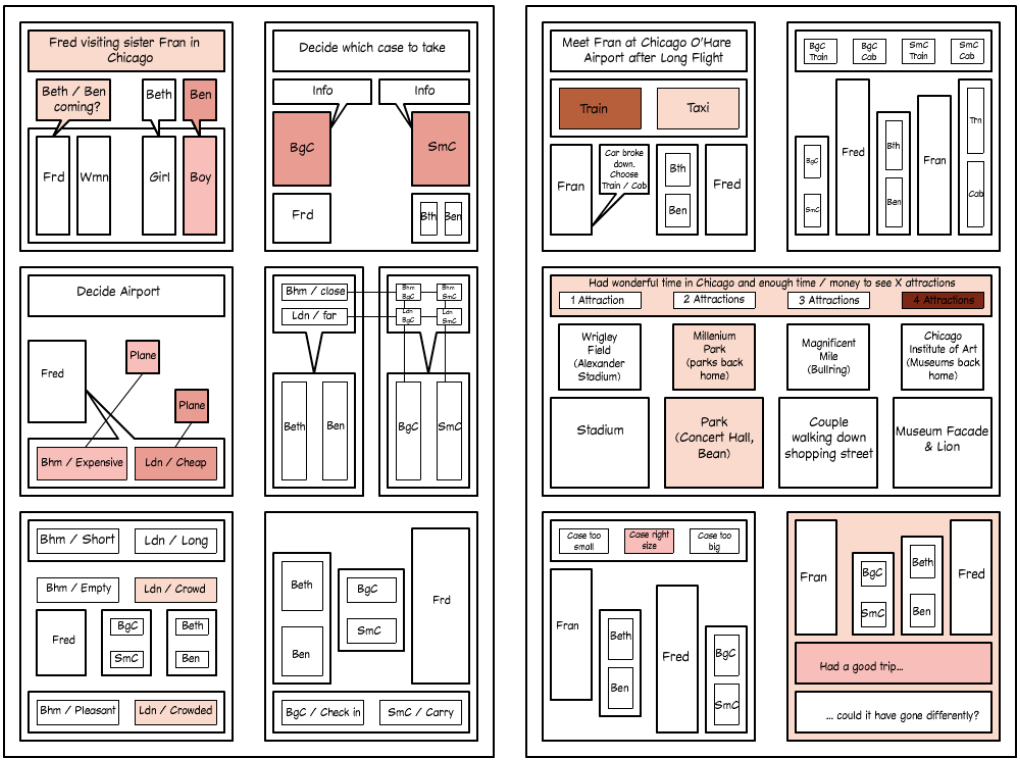


Figure 6.3.1.2 - Visualisations of responses to the digital comic

The heat maps show that a greater number of details are recorded in summaries of the paper comic in comparison with the interactive comic, and are distributed throughout the layout. These responses are varied, and include both high level and low level details. By contrast, responses to the digital comic contain fewer details, are more focussed around the second level of abstraction, and include references to decision points regarding the transport to get from the airport and which sites to see in Chicago from the third level of abstraction.

Responses given in answer to the question regarding the 'favourite' versions of the story are shorter than the summaries. One pupil merely writes "The one where they get to see all 4 attractions" in response to this question, for example. It is immediately noticeable that every single participant that uses the digital comic states that visiting four attractions in Chicago is their 'favourite' version of the story, while half the participants reading the paper comic express this preference. The majority of participants using the interactive comic prefer the family to take the train from the airport, whereas responses to this option in the paper comic are evenly mixed. As the train is cheaper and would allow the family to see more attractions in Chicago, the preference for this in the digital comic is consistent with the preference for the number of attractions the family visits. However, participants' preferences of airport to fly from in the interactive comic, which has a greater influence on the number of attractions that the family can visit, are evenly mixed.

The visualisation of the paper-based 'favourite' descriptions show responses are more distributed than those of the interactive comic, though not to the same extent as descriptions of the summaries. Almost the same number of references to the first and final panels can be seen in responses to 'favourite' versions of both the paper and digital comics. Over half of the participants reading the paper comic express a preference for a narrative in which the case is a suitable size for souvenirs, whereas only two participants express this preference in response to

the digital comic. Exactly half of the participants reading the paper comic also express a preference for a large case, though only three participants express a preference for a small case, meaning the remaining participants do not reference this panel. All of the participants using the digital comic reference this panel, with exactly half of the participants expressing a preference for the Big Case and the remaining half expressing a preference for the Small Case.

In the summaries and favourites of both the digital and paper comics, the majority of respondents make no reference to the last four panels of the first page. The visualisations also show that there are very few references to the journey from Chicago O'Hare airport shown in the second panel from page two in the descriptions of summaries or favourites in either the paper or interactive comics. None of the respondents reference information from the fourth and fifth panels in any of the descriptions of their 'favourite' narratives, and only three reference the fourth panel in their summaries: one reading the paper version and two reading the interactive version. These panels visualise the journey to the airport at a high level and show the cumulative impact of earlier decisions at a low level.

6.3.2 – Observations and Debriefings

The majority of users of the interactive comic stop reading sooner than readers of the paper comic, though there are no perceived differences between those that finish the paper or interactive versions of the comic first. The different times participants take to read the paper version of the comic are of a broader range than the times taken to finish the interactive comic. Discussions during the debriefing reveal that one reason for this is that the interface in the interactive comic facilitates the rapid exploration of panels, meaning that participants finish exploring this version of the comic more quickly. The second reason given is that participants are not motivated to explore all the possible branches in the interactive comic. This is because respondents feel they have explored as much of the interactive comic as they want, and that

there is no indication of the branches that have been explored or are remaining. Having each possibility printed on each piece of paper means that respondents can see the number of possibilities in the comic book, have a tangible sense of the beginning, middle and end, and can choose how much time to spend on each page accordingly.

The pages of the paper version of the comic are attached using paperclips, which can be removed easily. Several pupils take advantage of this in both groups, and remove the clips so that pages from the comic can be arranged side by side. It is unclear whether one pupil's actions in each group prompt others to follow, however. When asked about what instigates this behaviour, a pupil from group one responds that the ability to flick through and compare the pages is the most obvious method of exploring the comic. He also adds that this makes the paper version preferential to the interactive version, where there is no ability to do this. Three other participants agree with this statement in the first group. In the second group, one pupil states that the ability to compare comic pages in the paper version is reminiscent of "spot the difference" games in which images with subtle differences are placed side by side and the 'player' has to find them all. Two other participants in the second group agree that this adds a dimension to the paper version that is not available in the PC version. It is also worth noting that one participant in the first group attempts to simulate this behaviour with the interactive version by opening the comic in another browser window and placing the two instances side by side. The participant is politely asked to restore the desktop to its original setting in order to keep variables consistent in the study, though it could be argued that this is not consistent with participants reading the paper version, where such restrictions are not enforced.

In both groups, the remaining points raised in the discussions illustrate that opinions of the comic are mixed. Out of two groups of eighteen pupils, nineteen agree that they prefer the interactive version of the comic to the paper version. In the first group, nine pupils agree that

one of the reasons for preferring the paper version is that it is easier to navigate. One respondent in this group points out that the experience of using the digital version is 'faster', resulting in the retention of information being less likely, and three people agree with this statement. Ten people feel that there are more branches in the paper version than the digital version, but all agree that, even if the numbers are the same, they would not explore all of the possibilities in the interactive comic. One respondent argues that the interactive comic is "more adventurous, like hunting for treasure" and seven agree, with another participant contributing that it is better to have 'choice'. All participants agree with one point made: that it is 'nicer' to read from paper, as they prefer the feel of it.

In the second group, one participant comments that the paper version of the comic seems longer and more complicated, and that there is more to 'take in', with half the group agreeing. Another respondent argues that a computer is more fun than a sheet of paper to use, and those that prefer the interactive version agree. However, those that state the paper comic is their preferred version of the comic agree that the interactive version is more difficult to use, with one participant stating "It's easier to read a book than write a book". The entire group agree that it is more difficult to compare different versions of the story in the interactive comic than in the paper version. Those that prefer the interactive version, however, feel that the interactivity facilitates their understanding of the relationships between choices. Another participant states that the feeling of being able to dictate what happens in the interactive comic is a positive aspect, and seven agree. Within this group, participants agree that they would have preferred fewer pages in the paper version of the comic, and more choices with greater impact on the story in the interactive comic.

6.4 – Discussion

The range of responses identified in the summaries of the paper comic was not anticipated, but is consistent with the observed range of time the pupils spend reading this version of the comic. The division of abstraction levels in the design phase is therefore not reflected in readings of the paper comic, but users of the interactive comic provide descriptions related to the second and third levels of abstraction in their summaries. The third level references in summaries of the interactive comic relate to points at which users can interact, and there is a distinct lack of data related to other story content from this level of abstraction. It could therefore be argued that these data provide evidence that small amounts of interaction can influence responses to branching stories. This is consistent with the findings of Diakopoulos et al. (2011) who, as described in Chapter 4, finds that attention in interactive visualisations can be redirected with game mechanics. The findings in the present study suggest that interactivity in story visualisations can give rise to similar results, and direct attention towards interactive panels.

It is consistent with the summaries that users of the interactive comic recall the consequences of actions during these levels of abstraction in the descriptions of their 'favourite' outcomes. In spite of the design of the comic being non-task oriented, there is a clear preference for an outcome where the family can see all four attractions in the digital comic. This finding complements the work of Mitchell and McGee (2011) who, as discussed in Chapter 4, argue that users of hypertext stories anticipate purposes to their actions in pursuit of goals. Therefore, from the low level responses to the interactive comic, the family's ability to see all four attractions may be perceived as a goal of the comic. This is also consistent with the majority of participants' using the interactive comic choosing the train in the first panel of page two; which allows more attractions to be seen. It is not consistent with the decisions made regarding the choice of airport to travel from in the first page, which are mixed. This is noteworthy because

the different airports have associated costs, which have a higher bearing on the number of attractions that can be seen in Chicago than the choice of transport from Chicago O'Hare Airport. Further to the discussion of hypertext stories in Chapter 4, Urakami and Krems (2012) have shown that the greater 'causal distance' there is between events in hypertext story sequences, the less likely users will identify their correlation. As there is greater distance from the decision of which airport to use and which attractions to see than there is from the choice of which transport to take from Chicago O'Hare, this could explain why fewer participants identify that the choice of airport impacts their preference to see all the attractions in the comic. Additionally, this information is provided at the lowest levels of abstraction, which are rarely detailed in responses. The preference for the number of attractions visited in Chicago, for instance, is not complemented with details of what these attractions are. The heat maps help identify this trend, which shows that interactive comics and story visualisations can relate to other forms of interactive stories, and that designs of abstraction levels may not correlate with their comprehension.

For the paper version of the comic, the visualisations show that this could also be a goal-driven experience for some respondents, but the goals themselves are more varied. The heat maps across the numbers of attractions visited show that more respondents prefer the version of the story where all four attractions are visited than other amounts in the paper comic, but there is a distribution that contrasts responses to the interactive comic. Another preference that can be seen in the heat maps is the suitability of the size of the suitcase, which is interesting due to its position within the comic and because the majority of participants using the interactive comic do not reference this panel at all. Following the work of Diakopoulos et al. (2011) and Mitchell and McGee (2011) this therefore indicates that interactions could be embedded to direct both attention and goals in comics. In addition, the heat maps provide evidence that causal distance

affects the readings of the paper comic, as fewer participants choose both the big suitcase and the high number of attractions in spite of the suitability of this combination for the number of souvenirs that can be taken home.

The subjective opinions of the comics are wide-ranging, and reflect the dilemma of studying interactive stories discussed in Chapter 2 and the range of phenomena that could be explored with regard to user experiences as discussed in Chapter 4. However, the observations can be correlated with the debriefings; confirming Mitchell's and McGee's (2011) findings that users of hypertext stories do not explore all branches and Mangen's (2008) theory that the phenomenological differences between paper books and e-books can encourage different kinds of uses, also discussed in Chapter 4. The range of times respondents take over the paper comic reflects their perception of the length of content of the comic, which contrasts the perception of content in the interactive comic. Once participants have explored a number of branches in the interactive comic they feel they have familiarised themselves with the experience. Paradoxically, respondents express a preference for shorter paper comics even though they take longer to read them, and more options in the interactive comic even though they choose not to fully explore those that are available. Therefore, these findings both complement and contribute to existing work in the experiences of using hypertext stories and the differences between media. Future designs of interactive comics can be informed by these findings; employing interfaces that provide signifiers related to the branches explored and tangible elements.

6.5 – Conclusion

In contrast with the findings of Chapter 5, the visualisations in the present study provide insight into all the patterns identified in the qualitative data. This is due to the refinements in the visualisations made following the exploration of this method in Chapter 5, including the

addition of text within captions in the comic that clarify the design of certain episodes. Responses to the paper comic are varied, but recollections of the digital comic can be correlated with levels of abstraction. The findings from this study relate to previous work, and can inform designers of the potential impact of combining content with interactions. Similarly to the findings from Chapter 5, the present study shows that designs of interactive stories may not correlate with responses, but that comics could be used to both present the content and visualise the consequences. This therefore provides evidence that visualisations can be used to study the comprehension of stories, and responses to interactive comics can be assigned to levels of abstraction that could inform the refinement of future designs.

There are, however, issues with the study's design. Firstly, while the text within the comic can clarify the story, it could also be argued that it guides responses to levels of abstraction. None of the responses can be assigned to the highest level of abstraction if there is text that can correlate with the higher levels, and there is no data related to the absence of text in the present study. In addition, there are few references to the lowest level of abstraction in any recollections, which could be a limitation of either the comic's design or the method employed to obtain low level data. This could be overcome by separating levels during the design, development and analysis of interactive comics, and obtaining data from participants whilst they are interacting with comics. Such an approach may also be used to counter another limitation of the present study: that it is not possible to identify how the varied observations and responses obtained during the debriefings can be correlated with the different comprehensions of the story through the visualisations. Therefore, the remaining chapters of the thesis explore presentations of comics informed by the findings of this chapter in which levels of abstraction can be separated and responses can be obtained simultaneously.

CHAPTER 7: THE DEVELOPMENT OF A MULTI-TOUCH DEVICE FOR CREATING AND USING INTERACTIVE COMICS

7.1 – Introduction

In Chapters 2, 3 and 4, this thesis presents the case for employing comics to design, visualise and evaluate interactive stories, while the studies in Chapters 5 and 6 show that there are numerous advantages in doing so. Dividing stories into levels of abstraction and structuring these levels visually allows designs to be delivered directly to users as comics. These comics also provide visualisations in which the responses from users can be mapped against the original designs to identify correlations and discrepancies between creators' and users' comprehensions of stories. Though the studies in Chapters 5 and 6 provide valuable insights into the processes of designing and evaluating interactive stories, there are limitations related to distinguishing between levels of abstractions and identifying the specific relationships between comprehension and user experiences. While the distinction between levels of abstraction is a key concept in this thesis, the findings from Chapters 5 and 6 show that responses to these levels may not correlate with their designs. As stated in Chapter 6, this could be because of the lack of distinction between abstraction levels during both the construction and presentation of the comics. A system wherein abstraction levels are physically separated may counter this limitation. The present chapter therefore explores a form of creating and presenting interactive, branching comics on paper while integrating digital interfaces. The purpose of this investigation is to explore the physical division of abstraction levels for designing, creating and evaluating interactive comics. In addition, the device allows prototype comics to be developed and evaluated rapidly, and can be used to explore the phenomenological impact of introducing paper within the processes of creating and using interactive comics. Pilot studies are conducted in

which undergraduate students interpret the levels of the comic at different stages of the interaction, and explore the device as a potential environment for creating comics. Ultimately, a multi-user approach to creating and evaluating interactive comics is employed as a progression of the theories and methods explored in the thesis.

7.2 – An Environment for Creating and Using Interactive Comics

The present study investigates the development of an environment in which abstraction levels in an interactive comic can be physically separated for both creating and using interactive stories. To do this, a multi-touch table is developed upon which paper can be placed without compromising the interactions. The high levels of abstraction are drawn directly onto the paper, providing fixed level(s) of abstraction. Low level branches are projected underneath the paper, and can be manipulated by users via a multi-touch interface that recognises gestures through the paper.

7.2.1 – Design

The development of an environment in which levels of abstraction are physically separated is based upon the theoretical explorations in the thesis as well as Chapters 5 and 6; where the findings indicate that the tangible separation of abstraction levels could facilitate processes of designing and evaluating interactive stories. Previous work has explored the possibility and impact of integrating paper and/or other tangible objects into digital interfaces. The DigitalDesk of Wellner (1993), for example, provides a means of combining information in the world (on paper) with information in the computer that users can manipulate with simple gestures. An overhead projector is directed down towards a desk so that it can superimpose digital images on to paper, and a camera is mounted next to the projector so that it can capture both images on paper and movements made by the user. Thus, for example, a page containing a graph of

experimental results could be pointed at by the user. The camera would capture both the graph and the gesture. The graph would then be compared with similar graphs held in the computer and the gesture would be interpreted as a request for information. The computer would then project a similar version of the graph on to the paper (Wellner, 1993). Subsequent work reports variations on this basic concept of projector and camera interfaces. For example, in the Triangles interface (Gorbet et al., 1998), an audio comic book is created for the story Cinderella2000. To create a version of the story, children connect triangular pieces (embedded with a microprocessor) in different configurations to produce variations on the story that arise from combining events in different sequences. The user can therefore create different 'readings' of the story by reordering events (Gorbet et al., 1998).

In the present study, the physical object is the paper on which a comic is drawn or printed. The paper therefore provides fixed, upper levels of abstraction, and a framework in which multiple readings are possible. Based upon the findings of the previous chapters in the thesis, it is argued that this division has the potential to facilitate design processes where the distinction between levels of abstraction may not be clear. For the purposes of evaluating such stories, the separation of levels allows responses to be obtained according to these levels specifically, and to explore the potential tangible and phenomenological benefits of incorporating paper as discussed in Chapter 6. Table 7.2.1.1, therefore, shows how the design process for interactive comics discussed in Chapter 3 is adapted to the environment for developing and using interactive comics in the present study.

ABSTRACTION	ENVIRONMENT
TOP LEVEL(S)	PHYSICAL PAGE User has no control over layout of panels on the page
MID LEVEL(S)	MULTI-TOUCH INTERFACE User can manipulate projected objects
LOW LEVEL(S)	OUTCOMES Response to User's actions is projected within the page

Table 7.2.1.1 - Adapting the design process for interactive comics to the multi-touch environment

7.2.2 – Hardware Prototype

With the design established, a hardware environment is created to accommodate the physical division between levels of abstraction on paper and screen. To an extent, the application adopted follows Wellner (1993) and the combination of projector and camera to support user interaction. Although this would support most of the interaction that is required, multi-touch capabilities are also incorporated into the environment to facilitate editing stories and multi-user operation for evaluation purposes.

Figure 7.2.2.1 shows the prototype device developed for this study. This prototype uses a desktop computer connected to a webcam and projector, and incorporates a rigid, clear acrylic sheet with 100 infrared LEDs positioned around its perimeter. The sheet is an oblong shape of

24 centimetres by 30 centimetres, is 1 centimetre thick, and suspended between two desks above the webcam pointing upwards towards it. The webcam is covered with an infrared filter that allows the camera to detect the light from the LEDs refracted down from the acrylic sheet when pressure is applied to its surface. The LEDs are spaced at around 1.2 centimetres and attached to the sheet using electrical insulation tape. Each LED has a nominal voltage of 1.5 and a maximum 2 volts limit. Driving the LEDs at 1.65 volts produces acceptable touch sensitivity, and the camera system is able to detect hundreds of simultaneous pressures upon the acrylic sheet's surface. The sheet itself is coated in silicon, which helps secure the paper during drag motions across the surface. The projector is positioned around 80 centimetres beneath the sheet pointing down at a mirror that reflects images from the computer through the acrylic sheet and onto the surface of the paper. A high degree of accuracy can be attained without the need for direct contact with the screen by the finger by utilising the reflection of light. In suitable lighting conditions, and following calibration, the software is able to recognise many simultaneous gestures accurately through the acrylic sheet with paper placed on top. This allows for the exploration of combining paper-based comics with multi-touch interfaces, and facilitates the exploration of different comic designs through rapid prototyping and evaluations.

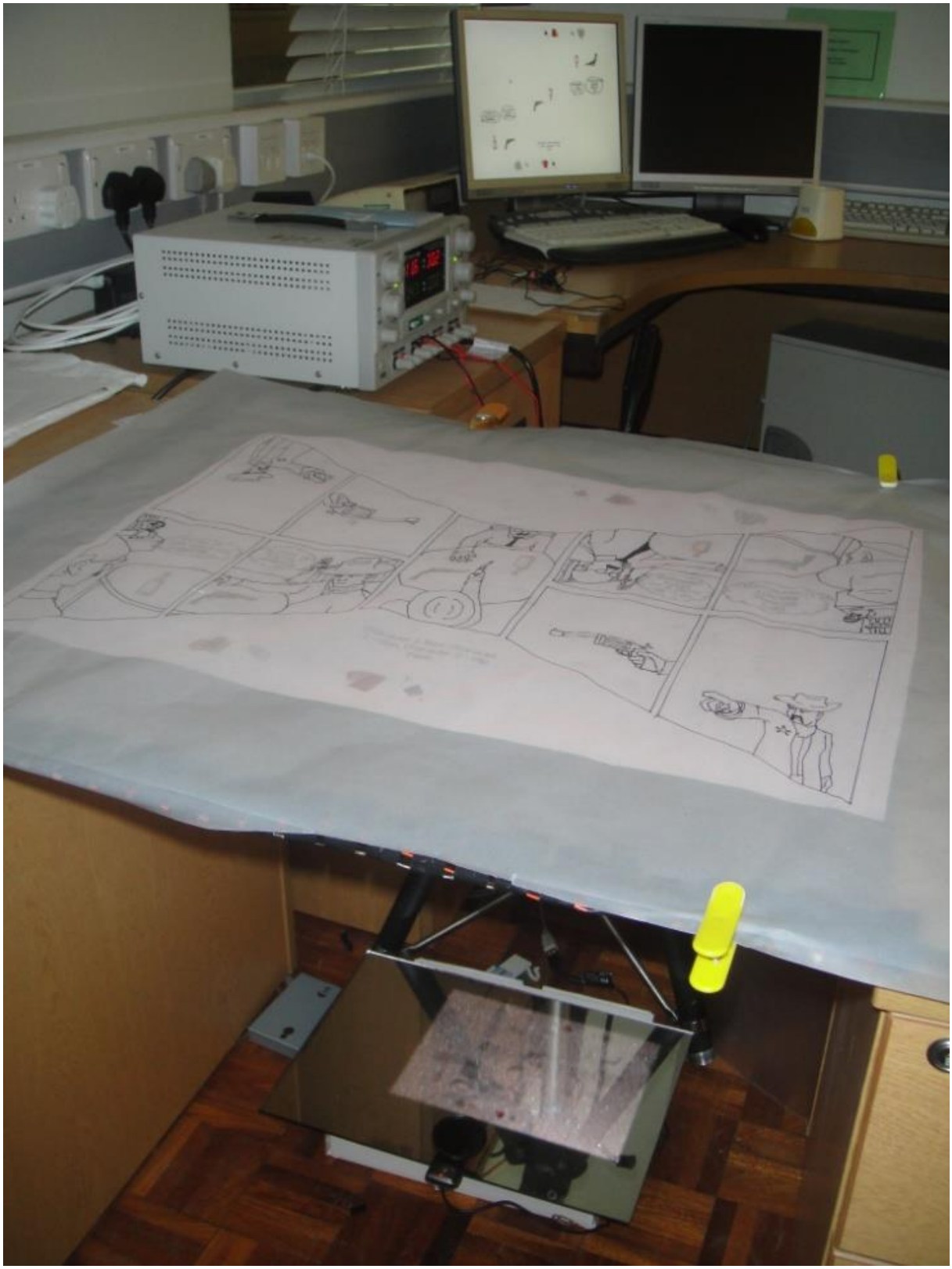


Figure 7.2.2.1 - A prototype for creating and using interactive comics

7.2.3 – Software Prototype

The software application is designed to display objects and outcomes from branches that are projected onto static comics that have been drawn on drafting paper and are placed upon the multi-touch surface. In Chapter 6 it is observed that users of interactive comics do not explore all the possible branches. One of the reasons identified for this is that users of interactive comics cannot see the different possibilities, which relates to Mangen's (2008) theory of the phenomenological differences between reading from paper and screens as discussed in Chapters 4 and 6. A new interface informed by these findings is therefore designed in this study based upon the dragging and dropping of objects within sections of panels, which is designed to visualise the possible options and remaining combinations available to users.

Initially, objects are presented to the user in a separate 'inventory' section of each comic. Each object has a corresponding region in the comic, which is highlighted to the user once the object is touched. The objects can then be dragged into their corresponding regions by swiping them across the page, as shown in Figure 7.2.3.1. These objects may have individual actions associated with them, such as the rendering of small amounts of dialogue. In all cases, the objects contain variables that create narratives when combined with other objects in the comic. One of the key features of the software is its multi-user drag-and-drop facility. The software can track finger touches and follow each of them on the screen during dragging gestures whilst assigning individual identifiers to them. Each region containing the object also keeps the identifier of the finger that first touched it. This means that different instances of the same inventory can be shown on the comic and used by multiple participants without conflicts arising if participants try to use the same object, as depicted in Figure 7.2.3.2.

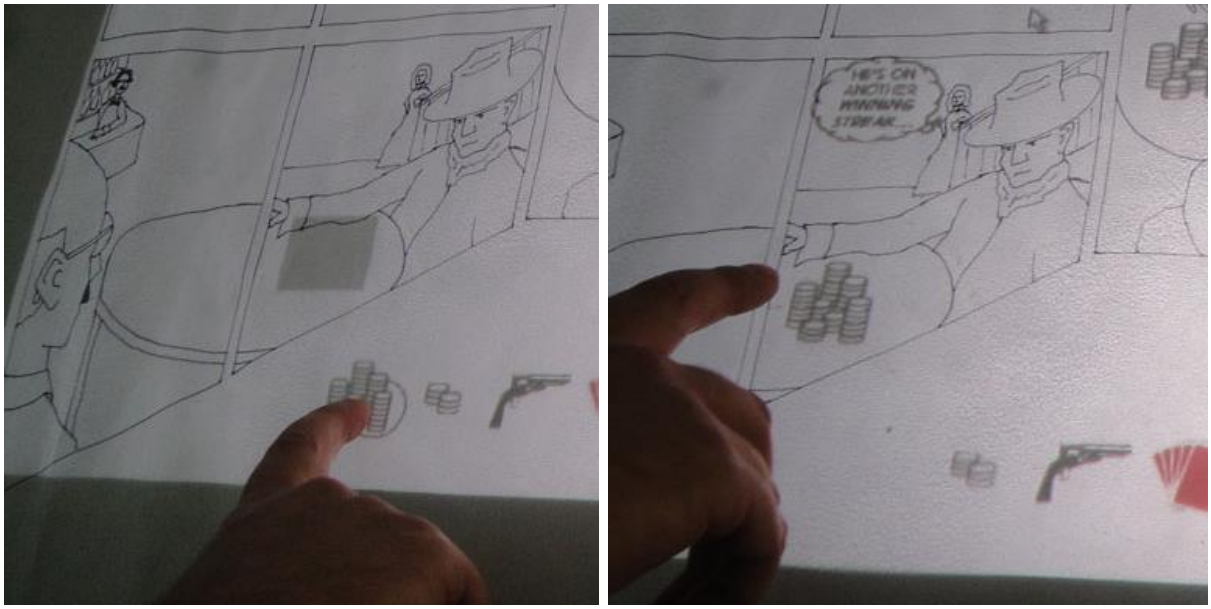


Figure 7.2.3.1 - Dragging an object from the inventory into a region of the comic

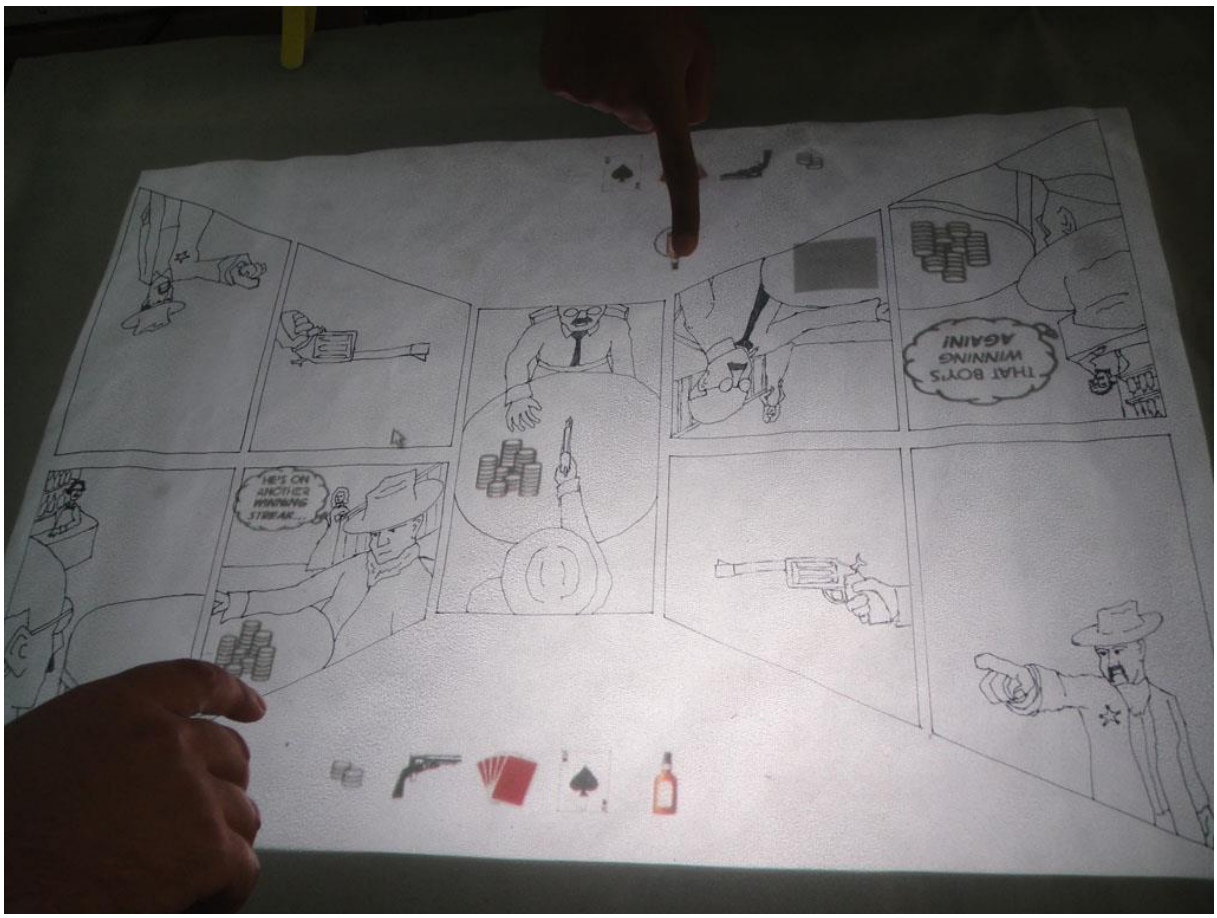


Figure 7.2.3.2 - Presenting instances of inventories to different users of the same comic

Simultaneous drag-and-drop actions for different regions and objects are therefore permitted, providing multiple participants the capability to make alterations to the narrative(s) simultaneously. When all the available regions within the page are filled, the result of the combined options is projected onto the paper as depicted in Figure 7.2.3.3. Users can therefore see the result of the combination of objects chosen, and the remaining objects in the inventory with which the used objects could be swapped. Everything is made visible on the page at once in order to provide enough visual information for users to determine which combinations they had and had not chosen previously.

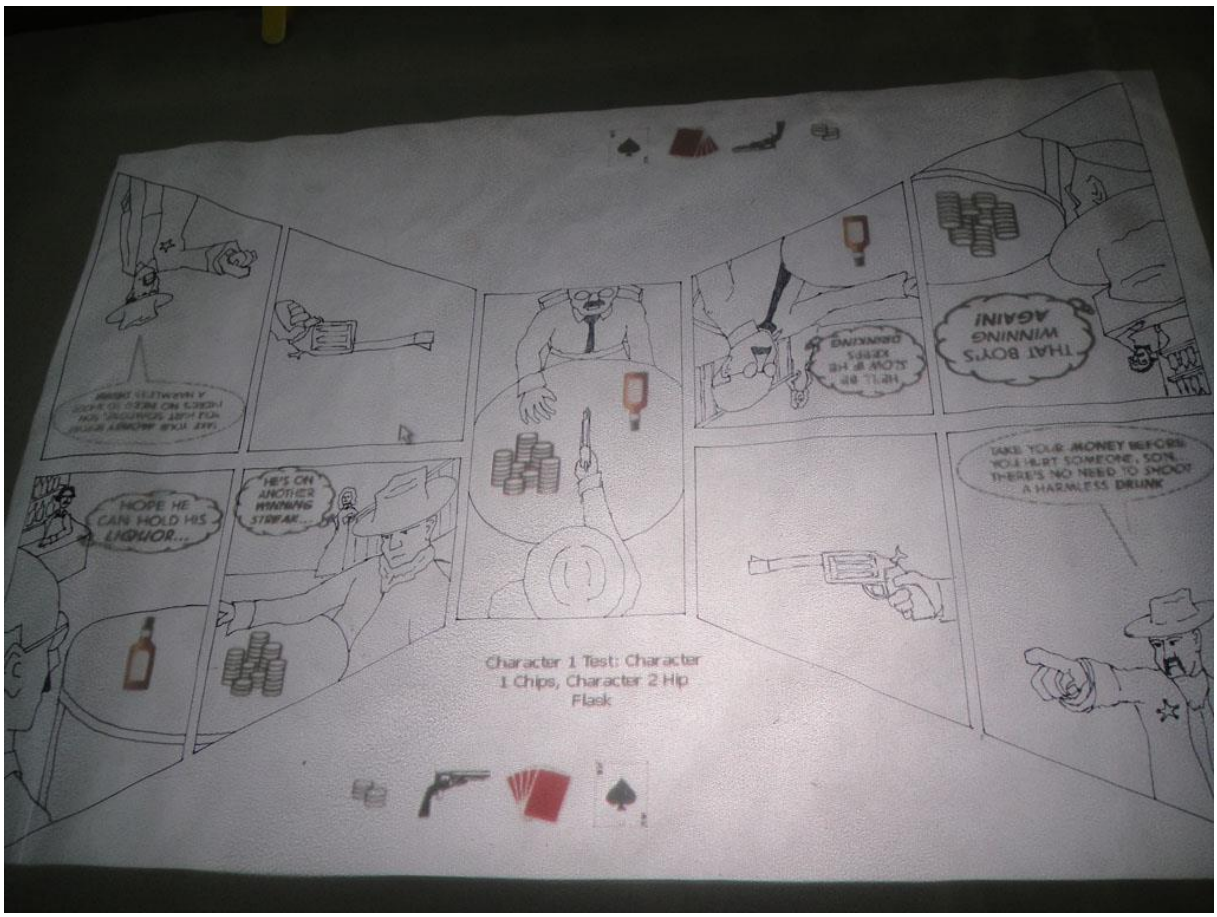


Figure 7.2.3.3 - Completing a scenario in an interactive comic

The multi-touch interface is also implemented within the creation process; simplifying the augmentation of the hand-drawn comics with digital pictures or text. Once the paper is placed on top of the surface, users can draw regions onto the comic in which objects can be contained or dragged into, or in which the consequences of dragging objects into other regions can be displayed. An example of this activity can be seen in Figure 7.2.3.4. The software contains a simple editing environment for programming these regions, which allows for each region to have various functions associated with them if required. This provides users with enough flexibility to draw regions within comics and iteratively assign and test their function(s). When combined with hand-drawn images, this allows for the rapid prototyping of branching comics. Following the studies in Chapters 5 and 6, this is deemed useful for rapidly and iteratively exploring the impact of creating and assigning content to various levels of abstraction in accordance with the results of evaluations.

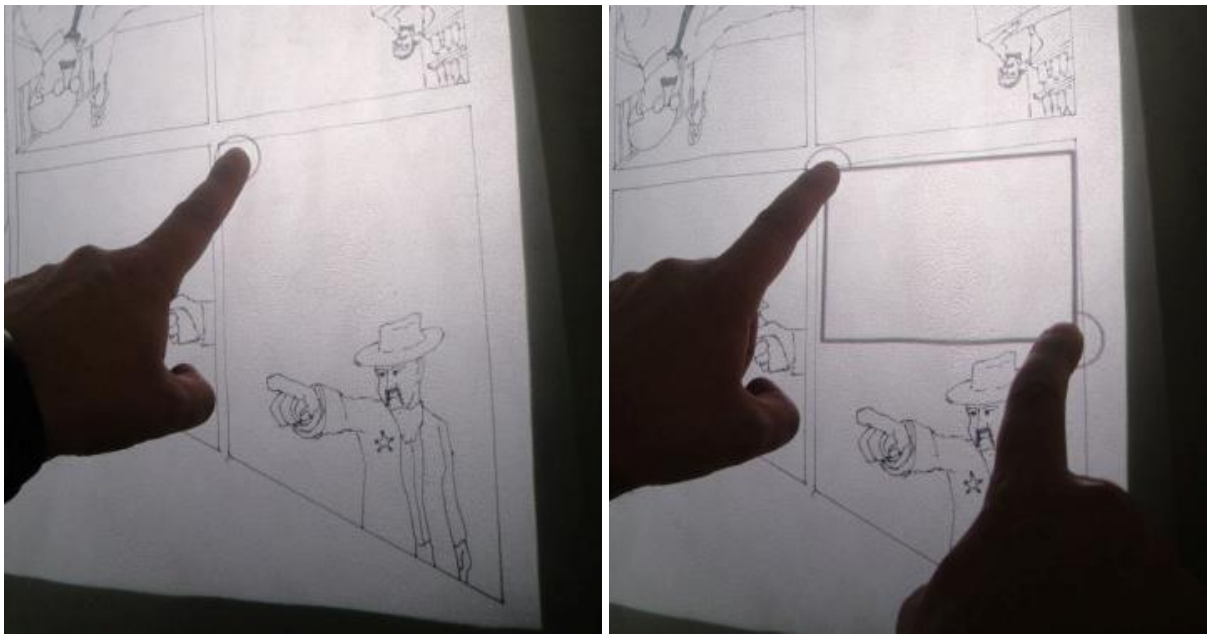


Figure 7.2.3.4 - Drawing a dialogue region in a comic

7.3 – Pilot Study One

7.3.1 – Comic Design

Following previous evidence that interactive, branching stories may be goal-oriented, the first prototype in the present study is designed to explore how users may respond to a specific goal embedded in a story. The first comic developed is a single-user experience of a story depicted across two physical pages. In the first page, a homicide crime scene is sketched in one panel, followed by panels depicting the analysis of evidence and the interview with a suspect. In accordance with the approach of employing abstraction levels, the comic drawn on the page provides a limited amount of information, though it describes that a crime occurred and an investigation followed both visually and textually, as shown in Figure 7.3.1.1. During this pilot study, an investigation into the division between images and text is not explored, although this is deemed to be potentially beneficial in the findings from Chapter 6. However, this is explored in subsequent studies in the thesis once the potential of the environment is described in the present chapter.

Figure 7.3.1.1 - First page of the comic in the first pilot study (high levels of abstraction)

In the present comic, lower level narratives, such as the evidence analysed and the suspects questioned or charged over the murder, emerge as the user decides which evidence or suspects to investigate from a number of options provided in the corresponding inventories. An example of this activity can be seen in Figure 7.3.1.2. From three possible choices, the user can drag a piece of evidence into the crime scene panel and see its analysis projected within the paper shown in the second panel. The user can then 'interview' one of three possible suspects and see how their testimony compares with the evidence available. In this way the comic contains different content depending upon the interactions of the user, and thus can be read repeatedly and in different ways with up to nine possible combinations.

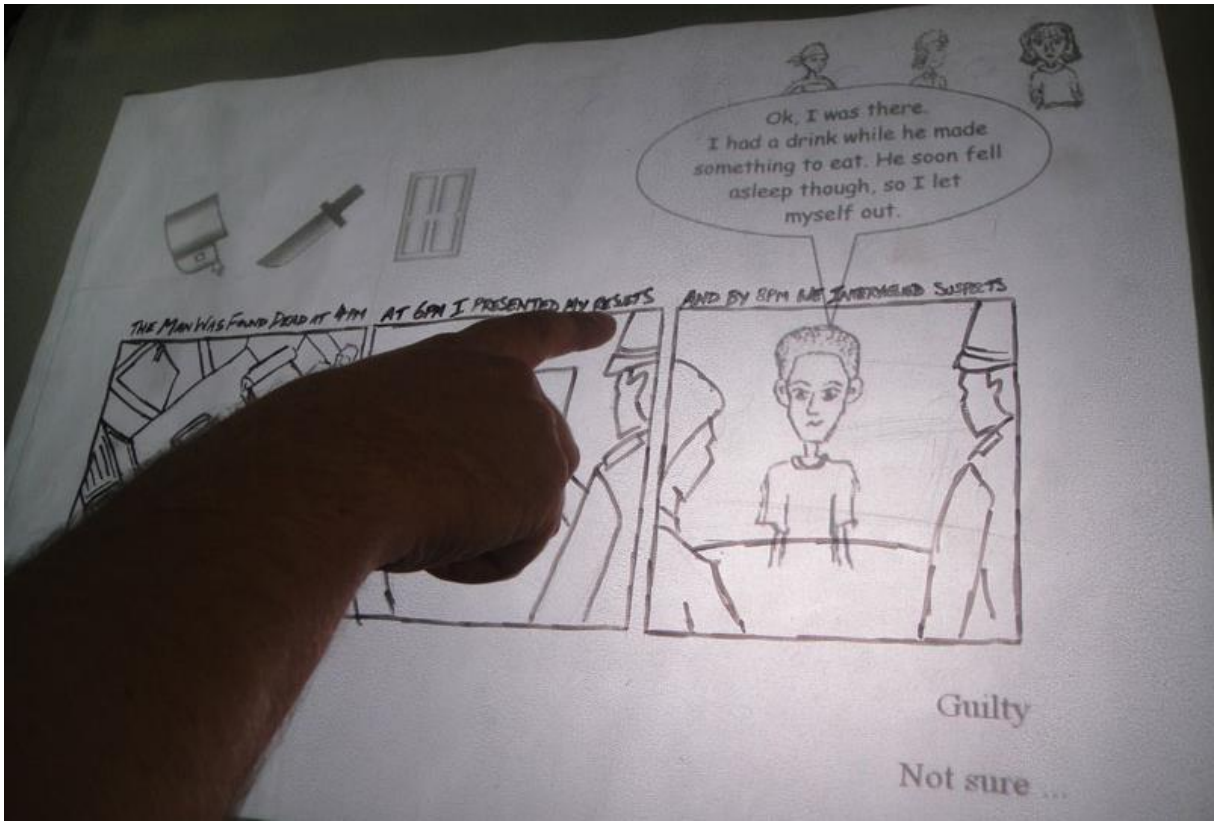


Figure 7.3.1.2 - Interacting with the first page of the comic in the first pilot study (low levels of abstraction)

Though the combination of options is stored in the program, there is no visual indication of the impact each combination has at this stage. The user is required to evaluate the narrative presented to them through the interactions, and make an informed decision as to whether the suspect chosen is 'Guilty'. Once this decision is made, the program prompts the user to 'turn the page' and progress the story to the trial scene, as depicted in Figure 7.3.1.3. Again, the limited information provided in the page simply indicates that a trial is taking place, and the player determines the outcome of the trial by the suspect chosen on the previous page and the evidence upon which they are relying, as depicted in Figure 7.3.1.4. The scene concludes with either a 'guilty' or 'not guilty' verdict depending upon whether the right suspect is identified and the correct evidence is chosen to support the case. The use of a verdict is intended to indicate to the user the designed goal of the comic. If the user is unsuccessful in identifying the correct combination of evidence and suspect, then he or she would be prompted to go back through the comic to alter the events in the previous pages or panels until the correct combination is identified.

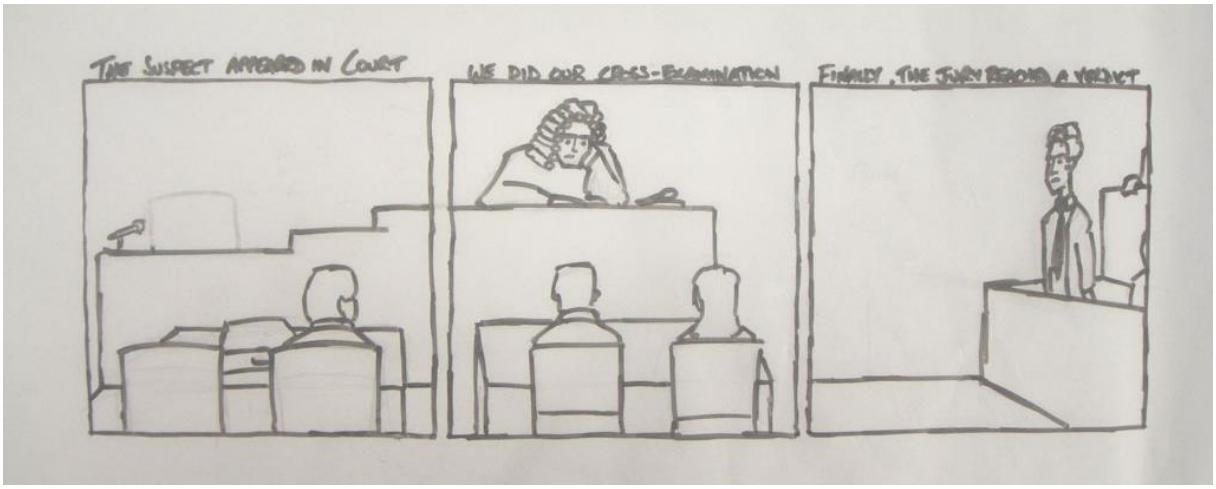


Figure 7.3.1.3 - Second page of the comic in the first pilot study (high levels of abstraction)

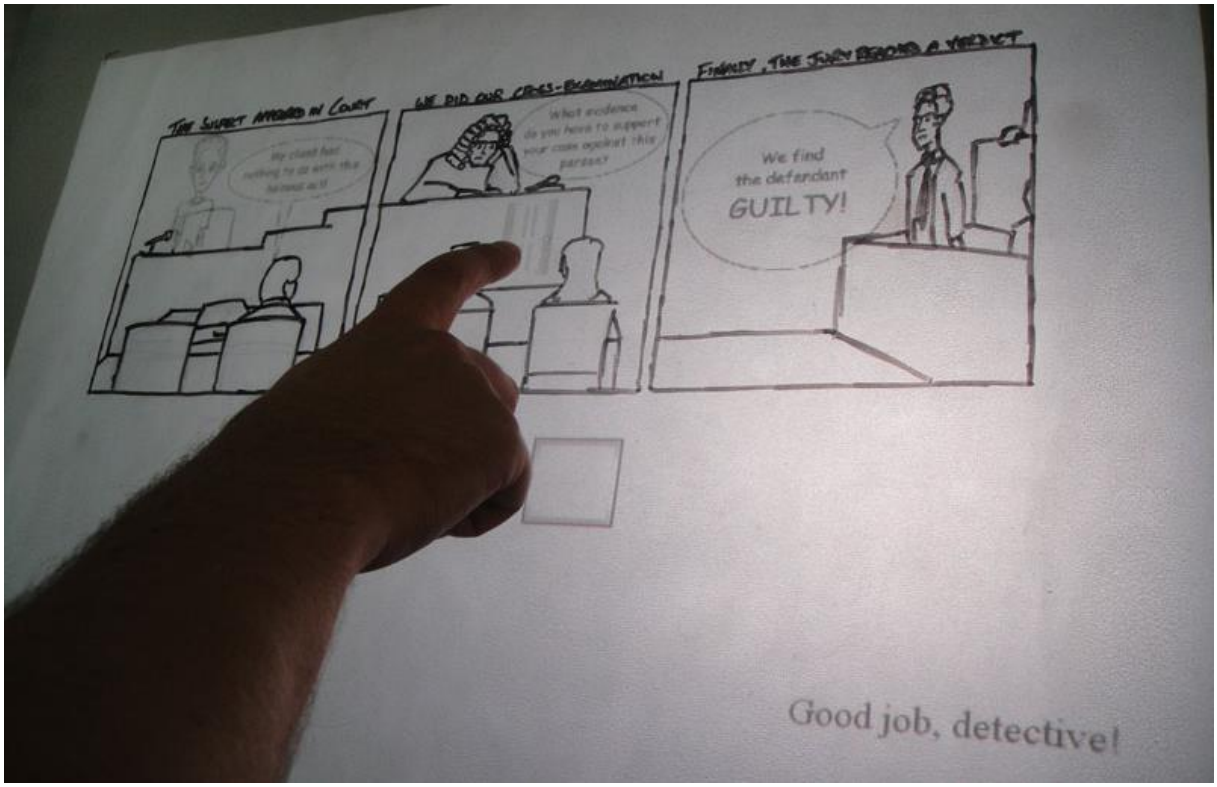


Figure 7.3.1.4 - Interacting with the second page of the comic from the first pilot study

7.3.2 – Responses

When testing the first prototype, three undergraduate participants are presented with the paper version. Having read both pages, they are each able to provide a coherent account of a 'murder enquiry'. When the digital augmentation is added, the participants are able to select and manipulate the objects in order to create different outcomes in the subsequent panels. While the participants take on the role of the investigator for the prosecution, the program ultimately judges the outcome based upon the predefined goal. This opens the experience to criticism from all the participants whose arguments are not accommodated in the comic. Debriefings with participants reveal that, though a specific goal had been programmed, the values and meanings attributed to evidence and testimony are hidden from the readers, meaning that the reason(s) for obtaining either a 'Guilty' or 'Not Guilty' verdict are unclear. Participants also express

frustration with the need to physically remove and replace pieces of paper from the surface of the table in order to go back to the beginning of the scenario and make alterations. The authored, goal-oriented design is therefore inconsistent with the readings in this case.

7.3.3 – Discussion

While the top-level narrative is accessible to participants, the lower narrative levels are too specific as they are aimed at a predetermined goal. As none of the participants in the study from Chapter 6 express any frustration related to their goal-oriented recollections, it could be surmised that the present study shows directing interactive story experiences to specific goals could be more frustrating to users than when goals can be inferred from the placement of story content and interactions. In terms of the designs of such comics, therefore, the implementation of specific goals may need to be validated with user studies related to intended story experience(s). The use of paper also reveals current limitations in the approach to presenting interactive branches. Although comic books are traditionally split into pages, as well as panels, attempting to create branching stories spread across pages in the current approach is cumbersome. Therefore, for the remaining studies, branching designs with multiple possible conclusions displayed within single pages are employed.

7.4 – Pilot Study Two

7.4.1 – Comic Design

Following the findings from the first pilot study, the second comic presents the story on a single page, and does not incorporate a fixed single goal. A multi-user aspect is also incorporated in this comic, wherein a competitive or collaborative approach to the construction of narratives is employed, as proposed in Chapter 4. Figure 7.4.1.1 shows the comic explored in the present study, which is a generic Old West bar scene depicting two individuals sitting opposite one

another at a table, with spaces available for objects, dialogue and sound effects. In the first two panels, witnesses are rendered in the background with space alongside them for dialogue, whilst space is given on the table in the foreground for objects. In the middle panel, the individuals sitting at their table are depicted with one pointing a gun at the other. The final two panels depict a close-up of a hand holding a gun with space for sound effects, followed by a stereotypical sheriff pointing his finger and calling out, with space for speech above him. While there are five panels within the story, nine panels in total are rendered showing the same story in different orientations so that two users at opposing sides of the page can operate the device. The middle panel is shared, as it is an overhead view of the men sitting opposite one another at the table. This is designed to resemble the position of the participants, and provide a visual indication of the assigned role for each user.

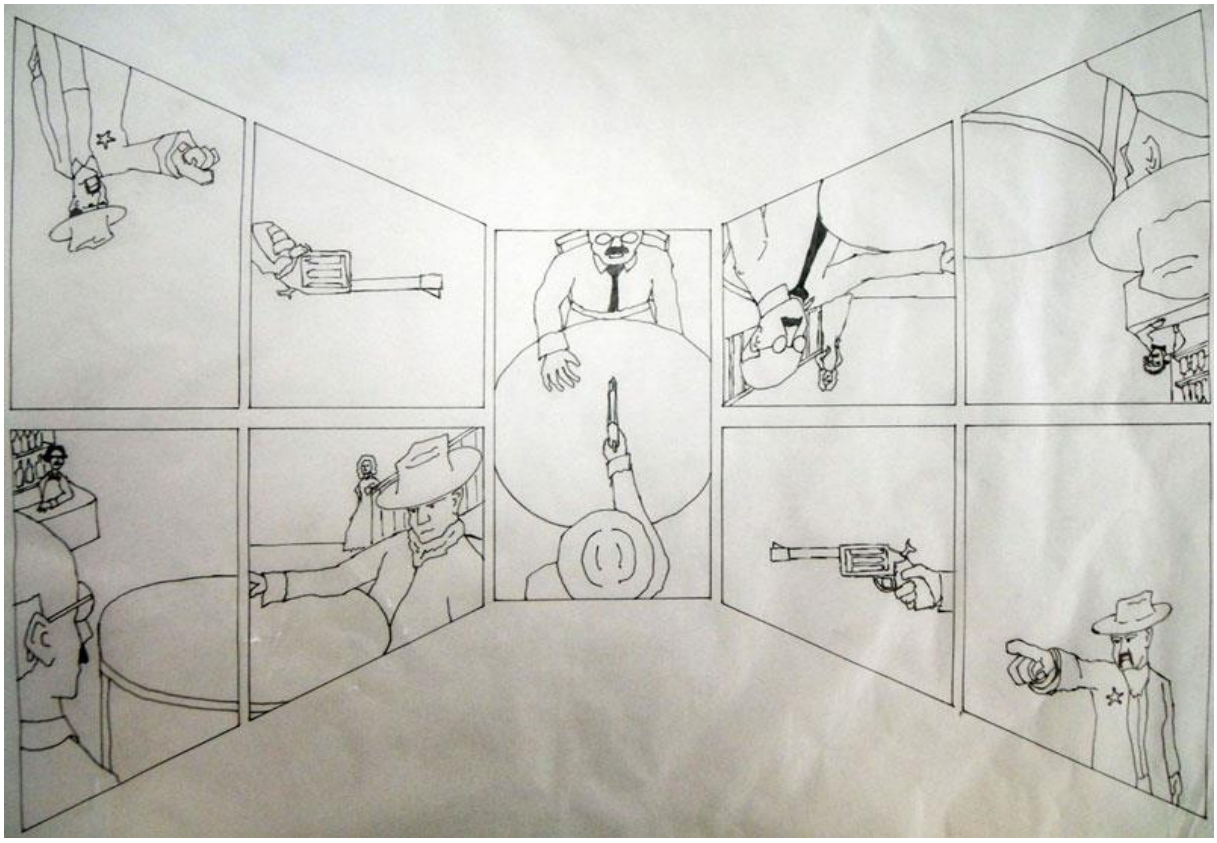


Figure 7.4.1.1 - The comic from the second pilot study (high levels of abstraction)

The description above is an overview of the story drawn at the top levels: two men are sitting at a table in a bar when one pulls a gun on the other, as witnessed by a bartender and a dancer, before a Sheriff intervenes. These levels are depicted purely visually and separately on paper to explore how high level and low level responses can be compared, following the findings of Chapter 6. The lower level details of what happens within this story are determined by the combined participation of two users, who can drag and drop objects onto the table. Each user has the option of dragging one object into his or her region on their side of the comic, which corresponds with their role within the story. In Section 7.2.3, Figures 7.2.3.1 and 7.2.3.2 depict these actions in the Old West comic whilst demonstrating the interface of the software environment. The objects are designed to be thematically related, such as whisky and gambling chips, but without obvious narrative repercussions. The individual objects provide users with some details regarding what the objects mean for the story via the thoughts of the bartender and the dancer, examples of which can be seen in Figure 7.4.1.2. The combination of options results in the completion of the scenario, such as the firing of the gun and the arrest of one of the men in Figure 7.4.1.3. In terms of the competitive/collaborative approach to the emerging story, the parallel narratives depicted are slightly different for their respective users, who are provided with exposition that relates to the impact the combination of objects has on their individual roles. This means that the meaning behind the objects and their combinations can be explored by the users themselves, rather than being judged by the program, which is intended to prevent any frustration on behalf of the users over the design of the comic and the interpretations of its outcomes as identified in Section 7.3.

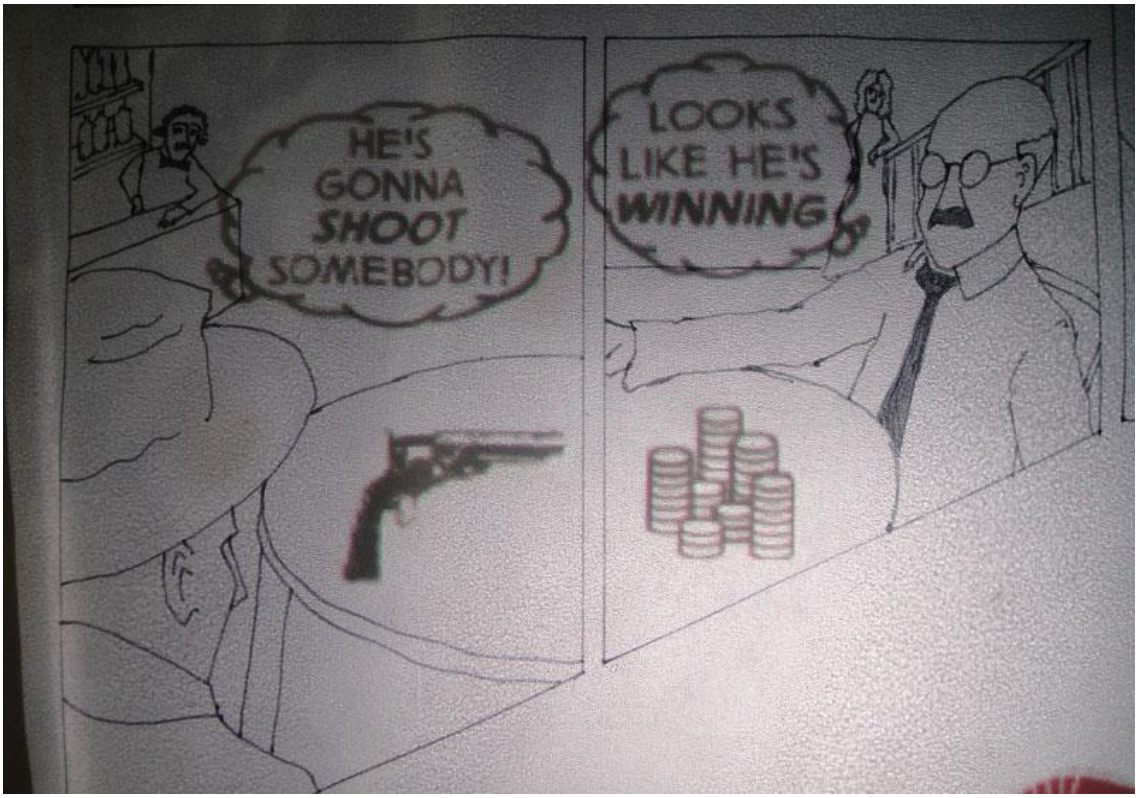


Figure 7.4.1.2 - Meaning attributed to objects through the thoughts of background characters

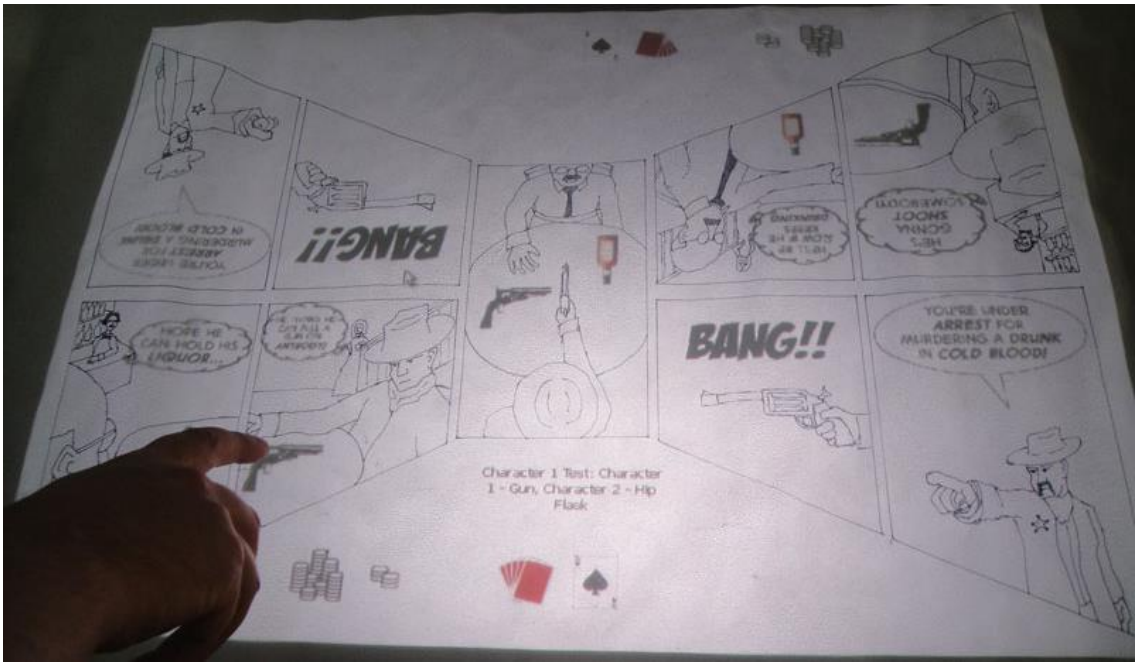


Figure 7.4.1.3 - Completing the narrative with the placement of objects

7.4.2 – Using the Comic

Two pairs of undergraduate students use the comic designed for the present pilot study. When reading the paper, prior to the program starting, all initial accounts are consistent with an Old West bar scene in which a Sheriff intervenes in an impending gunfight. All participants also assume that the man wearing the cowboy hat is the one holding the gun in the penultimate panel. Upon starting the program, each user takes on one role, facing each other across the table, and, in spite of the multi-touch functionality, readily adopting a turn-taking procedure as they participate (i.e., one person adds an object while their partner watches and waits for the outcome of this action on their side, before adding an object themselves. Once the final frame has been completed, users remove objects and replace them with other options. Some combinations of objects make more sense to users than others, having already read the 'top level' of the story. In the scenario, for example, a gun can be assigned to either the man in the cowboy hat or the man wearing spectacles. Yet, in the middle panel, the cowboy draws a gun towards the other man regardless of whether a gun has been assigned or not. The intention here is to exploit the potential ambiguity of the final two panels; where it is not shown who is holding the gun or who the sheriff is addressing. It could be, therefore, that the spectacled character is holding his own gun in this panel, and perhaps even fires upon the cowboy. Some of the outcomes are designed to depict such scenarios, as well as the more obvious conclusion that it is the cowboy's hand holding the weapon. Having already read the top level of the comic, all participants state that they initially find these dramatic shifts quite jarring due to the conflict with their assumptions. Nevertheless, there is less evidence of frustration shown than in the responses to the first pilot study in Section 7.3.

7.4.3 – Designing Narratives

The same participants involved in the reading of this comic are given the opportunity to design the comic at its lower narrative levels, giving them control of the actions associated with objects and their combinations. Of the four participants, two have prior experience programming and one is an illustrator. The fourth has neither programming nor illustrating experience. Three out of four participants have a general interest in comics. The editor is deemed to be accessible and easy to use for comics with a small number of branches resulting in between nine and twelve possibilities, such as those used in the story presented in Section 7.3. However, the participants feel that there could be problems for novice users wishing to create stories with larger numbers of branches, such as the thirty possible combinations in the present comic, due to the relatively obscure visualisation of the relationships between options within the editor.

In spite of their reservations with the editor while authoring the lower narrative levels, it is observed that participants quickly comprehend the relationships between objects, actions, and events, and how new narratives can be formed based upon these relationships. When it is suggested to participants that the paper should provide a story that would function independently of its multi-touch modifications, initially participants are confused by this requirement, and it is interesting to note that this confusion is not apparent when the same participants are using the stories. When asked about the reasons for this, participants note that the allocation of spaces for additional narrative content is more complicated in the process of designing stories than it is in processes of allocating material to stories while using them. The illustrator in the group notes that such an approach could have limitations due to the need to project lower narrative elements underneath the top level, as there would be restrictions on how artwork can be composed and coloured, for example. However, after participants are encouraged to sketch out their own stories, the value of the paper-based approach becomes

more apparent. It is observed that participants are quick to understand the impact that their drawings have upon lower narrative levels of abstraction once their drawings are augmented via the editor. As a user with prior experience of integrating paper in their digital workflow, the illustrator comments that it is timesaving to be able to use paper instantly within the prototype, without having to scan the images in or to swap between different software and interfaces. More generally, the inclusion of paper results in a considered approach to authoring stories that could be digitally augmented.

7.4.4 – Discussion

Participants contest the specific design of the comic from Section 7.3 due to the logic employed within the authored goal. It is also quite difficult to go back and make alterations to this comic due to the limitations of embedding paper within a multi-touch interface. After removing a specific goal and presenting the comic on a single page, the comic from Section 7.4 shows that these limitations can be overcome, though there are some issues in identifying the relationships between variables when developing interactive comics. However, this is in contrast to the usage of the comic, where users are able to quickly navigate between options and identify which combinations they have and have not used already. The design of the interface therefore limits the impact of any potential phenomenological differences between paper-based and digital comics as discussed in Chapter 6. From the present study it is also noted that users are occasionally jarred by the changes in the narratives resulting from their interactions. Nevertheless, by omitting a predesigned goal, the act of interpreting the comic is more accessible to participants.

7.5 – Conclusion

The physical separation of abstraction levels in comics allows data to be obtained related to these levels, but there are associated challenges. Attempting to incorporate multiple pages and design specific goals for users can result in frustration, and users could still find the experience of exploring narratives within a single page jarring due to conflicts with their expectations. However, the adoption of a multi-user approach based upon the theories and methods explored in the thesis so far shows promise. In addition, the initial findings from the present chapter's studies show that separating levels of abstraction physically with paper has potential advantages in terms of exploring designs and behaviours related to creating and using interactive stories. Therefore, the final study in the thesis continues to explore these phenomena using methods informed by the present chapter's findings.

CHAPTER 8: A STUDY INTO CREATING, USING AND EVALUATING INTERACTIVE, BRANCHING COMICS

8.1 – Introduction

The studies in this thesis demonstrate the potential for comics to be employed to design, visualise and evaluate interactive stories, while highlighting the dilemma of creating content that users can manipulate. Chapter 7 illustrates the additional considerations involved in creating environments in which participants can create and use interactive stories. This environment is informed by previous theories and methods, and refined through the findings from the pilot studies. Previous studies in the thesis show that, while visualising responses to heat maps can reveal interesting phenomena and trends, they do not allow for responses to be correlated with user experiences precisely, or with abstraction levels when the designed levels are not separated during the studies. Based upon these findings and theories related to role-play in interactive storytelling as discussed in Chapters 2 and 4, the environment developed in Chapter 7 allows for multiple participants to create and use interactive stories simultaneously, producing qualitative data via both protocols and designs in the process. The present chapter explores these phenomena in depth; comparing comprehensions with user experiences, and how these could relate to processes of designing interactive comics. Having identified a range of phenomena related to comprehensions and user experiences in previous studies, it is argued that this approach provides additional insight into the behaviours of users that can be used to inform the design and development of interactive stories.

8.2 – Study

The recollections analysed so far in the thesis have been valuable for identifying the impact of branching and interactivity upon the comprehension of comics. Debriefings illustrate that the experiences of using comics emerge as important to participants, and may impact their comprehensions of stories. In the present chapter, a system of analysing protocols retrieved during the process of using comics is employed. This enables interpretations from different levels of abstraction to be taken while comics are used, and for these interpretations to be mapped against user experiences in parallel. Comparing previous work with the studies in this thesis shows that there is a recurring theme associated with the dilemma of designing and studying content that users can interact with. The approach adopted in the present study aims to explore this dilemma in greater depth by introducing a method of evaluation that obtains data from multiple participants while they comprehend stories, and compares their comprehensions with their designs. This process is derived from theories that explore solutions to the dilemma of authoring interactive stories, particularly with regards to role-playing in interactive storytelling as discussed in Chapters 2, 4 and 7. In accordance with these explorations, the specific questions investigated in the present study are as follows:

1) Can users of interactive comics also be creators of interactive, branching comics?
2) How do the processes of using, creating and designing interactive, branching comics compare and contrast?
3) Can these findings be used to inform the designs of interactive stories?

8.2.1 – Using an Interactive Comic

The first part of the study involves exploring comprehensions of a comic previously designed. As described in Chapter 7, the design of the Old West comic is based upon the application of

theories developed in this thesis and refinements to the interface informed by the study in Chapter 6. This design incorporates the physical division of the high, visual levels of abstraction combined with an interface that counters phenomenological issues related to exploring story content digitally. As a representation of these considerations, the Old West comic demonstrates how designs can evolve with a more informed interpretation of theory following studies with potential users. Whilst the pilot studies from Chapter 7 show that participants face a period of adjustment related to the change in narratives following interactions, this is perhaps inevitable in a design that requires users to change and then use an entire story at once. Further analysis would provide insight into this aspect of the design.

8.2.2 – Creating an Interactive Comic

Following explorations of the comprehensions and use of the Old West comic, investigations are conducted into the creation of a comic based upon a similar framework. For this, a document is prepared that enables users to create their own interactive comic. In addition, a template layout of panels is prepared for the study based upon the panel layouts employed in the Old West comic, to encourage the design of multi-user comics. In the design document, participants are provided with three possible scenarios from which they could choose to create a story:

1) Two people having dinner in a restaurant
2) A police officer interviewing a witness at a police station
3) A medical doctor talking to a patient in a surgery

Participants are invited to choose three interactive objects to be integrated within their scenario from the following: a bottle (with liquid in), a knife, a mobile telephone, money, pills, a ring, and a wristwatch. The use of a familiar template, generic scenarios and loosely related objects is intended to provide a framework for participants to complete the task without compromising

the exploration of design processes. The document requests that participants select which scenario and objects they are planning to design around and to draw the top level of the comic themselves onto paper. Spaces are provided within the design document for participants to fill in the descriptions, dialogue and sound effects related to the choices and combinations of options. Once the document is filled in, the comics are input into the system described in Chapter 7 on the participants' behalves, ready for testing in the lab. A blank copy of this document is enclosed in the Appendix to this thesis.

8.2.3 – Method

Following the exploration of heat maps in the previous chapters, a more conventional system of verbal protocol analysis is employed in the present study to complement these findings and facilitate the accurate comparison between comprehensions, user experiences and design processes. The previous studies show that the mapping of responses against the visual layout of comics is a useful method for identifying patterns. Therefore, a form of data collection that allows the sequence of protocols to be recorded alongside participation with the comics visually is chosen for the present study. This is in accordance with methods for collecting protocol data through video recordings that can be categorised and analysed according to research question(s) and criteria (Walker, 2004; Bainbridge and Sanderson, 2005). For the present study, video recordings of users interacting with the comic and describing their comprehensions and experiences are employed to capture audio descriptions and physical gestures simultaneously.

Participants are asked to both use and create the comics in pairs, and four pairs of undergraduate students participate. It is deemed necessary to keep the sample size of participants to this number due to the volumes of qualitative data that can accrue through these methods (Dow et al., 2007; Mitchell and McGee, 2011; Seif El-Nasr et al., 2013). For recording the data, an overhead view would have been ideal to analyse both the interactions with, and descriptions of,

the comics, but is not possible in the environment. Nevertheless, a relatively high angle to the right of the multi-touch table pointing towards the surface is still possible, which captures gestures and protocols sufficiently well for comparative analyses. An example screenshot of the video data taken from this angle can be seen in Figure 8.2.3.1. Video recordings from this angle are taken of the interactions with the Old West comic, the other comics created, and the descriptions from participants of the comics they create.

Each person within the four pairs of participants is asked to take turns to give their interpretation of the 'top level', or drawing, of the Old West comic strip, following the observed trend of turn taking in the pilot studies from Chapter 7. Having interacted with the comic in their pairs, the participants give individual interpretations of the different outcomes following their combined choices of options. To obtain a spread of responses, and observe differences between different combinations, participants are asked to repeat this until they wish to stop. Though the comic is designed to show users all the possible combinations within its interface, it does not discourage users from choosing the same combinations more than once either by accident or by choice. In keeping with the nature of the studies in this thesis, users are not tasked with choosing different combinations, or finding all the possible combinations.

Having read the Old West comic, participants draw and design their own collaborative, branching comic using the instructions provided in the design template, and return these for testing the following week. Participants are asked not to collaborate with other pairs, or show their comic drawings or designs to anyone other than their partners in the exercise to avoid any predisposition in the designs or interpretations. During the following lab session each pair of participants is invited to read and interact with another group's comic. The design of this study is consistent with the readings of the Old West comic: readings of the comic at the 'top level' are recorded, as well as the interpretations of the different outcomes after participants choose

different options four times. As the authors are also present, they are invited to describe the intended, or designed, interpretations of their comics, and reflect upon how they are similar to, or differentiate from, the descriptions given from their readers. Apart from obtaining data comparing and contrasting the designs of creators and the experiences of users, the intended outcome of this process is to compare patterns in the data from the responses to the Old West comic with data that the same respondents subsequently provide in their descriptions of their design processes.

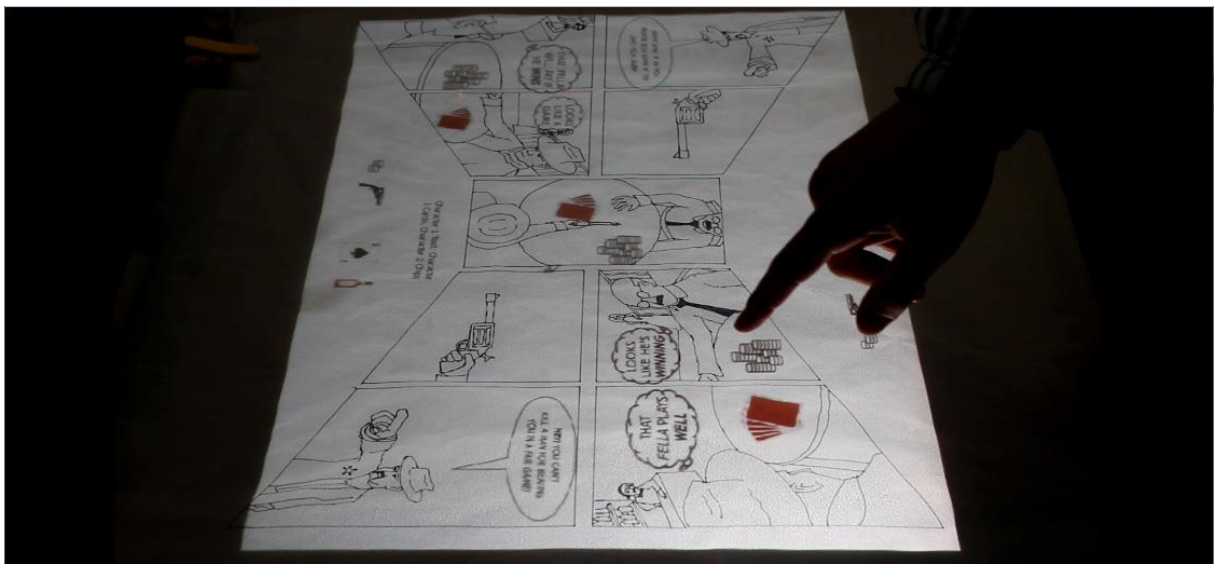


Figure 8.2.3.1 - A screenshot of footage from the video data

8.3 – Results

The results of this study provide insight into the relationships between using and creating interactive narrative experiences. There are patterns in the designs of each group that show relationships between their responses to the Old West comic, to comics created by other participants, and their approach to designing their own comics. These results are now presented.

8.3.1 – Group 1 (Participants 1 and 2)

In readings of the Old West comic, the first participant in this group provides basic descriptions of the 'top level' of the comic. The setting of a 'bar' is mentioned, and all of the characters in the first two panels are identified. It is described that the "gruff looking" man drew a pistol upon the "educated man", and that a "person of authority, a sheriff" intervened in the conflict. The second participant provides slightly more embellished details, stating that the setting is "clearly a bar", and that there is "someone drunk"; specifically the cowboy. This participant also mentions that he isn't sure whether the gun is fired in the penultimate panel. The remaining details given are the same as those provided by the first participant.

The participants decide to explore four combinations of options when providing low-level descriptions. The accumulation of explored branches helps participants make sense of the events within the scenario, as well as the specific outcomes of the combinations. Issues emerge regarding the experience of reading the story following interactions. During the second combination, participants are not sure whether the dialogue refers to characters in the foreground or background in the first two panels. However, they correctly assign the emerging dialogue during the remaining combinations.

The first two combinations these participants choose revolve around playing cards and gambling. The first combination results in the gun firing, and in the second the gun is not fired. The first participant recognises that the background characters are providing dialogue related to the game being played, although the second participant feels that the game has no bearing on the outcome of the gun being drawn. In the third combination, which involves a whisky bottle, the participants feel confident that the outcome is the result of a drunken brawl, and that the background characters clearly give information related to this. In the fourth combination, the spectacled man is assigned a gun, and the cowboy is given a small pile of gambling chips. As

the centre panel always depicts the cowboy drawing a gun, this scenario is designed to imply that both characters draw pistols on one another. This is recognised as being the case by the second participant, though the first participant is more hesitant about which character's gun is being shown in the penultimate panel. Both participants recognise that the sheriff is addressing the spectacled character in the final panel when he persuades the spectacled man that there's no point shooting a 'looser'. Both participants stated that this combination is "interesting", and give the most detailed descriptions. They decide to finish browsing the combinations at this point.

For their designed comic, this group creates a scenario in which two investigators are discussing a crime scene: Sherlock Holmes and Doctor Watson. The first two panels depict the crime occurring: an altercation between two men. The following three panels are designed to depict Holmes and Watson discussing what has happened: more specifically, Watson provides his reasoning in the fourth panel, and Holmes either confirms or corrects this conclusion in the fifth panel. A still from the video of this comic can be seen in Figure 8.3.1.1.

The possible objects that could be combined within this comic are a knife, a bottle and money. The participants created detailed possibilities at the low level of the comic. The centre panel depicts a man lying on the floor. However, depending upon the combination of options chosen, this man is either the victim or the assailant, and either dead or alive. The preceding two panels show the altercation between the two men, which range from being a drunken brawl resulting in one man passing out to a violent mugging resulting in one man dying. The final two panels also reflect the severity of the preceding incident, with Holmes either congratulating Watson for identifying a worthwhile case, or berating him for wasting the great detective's time.

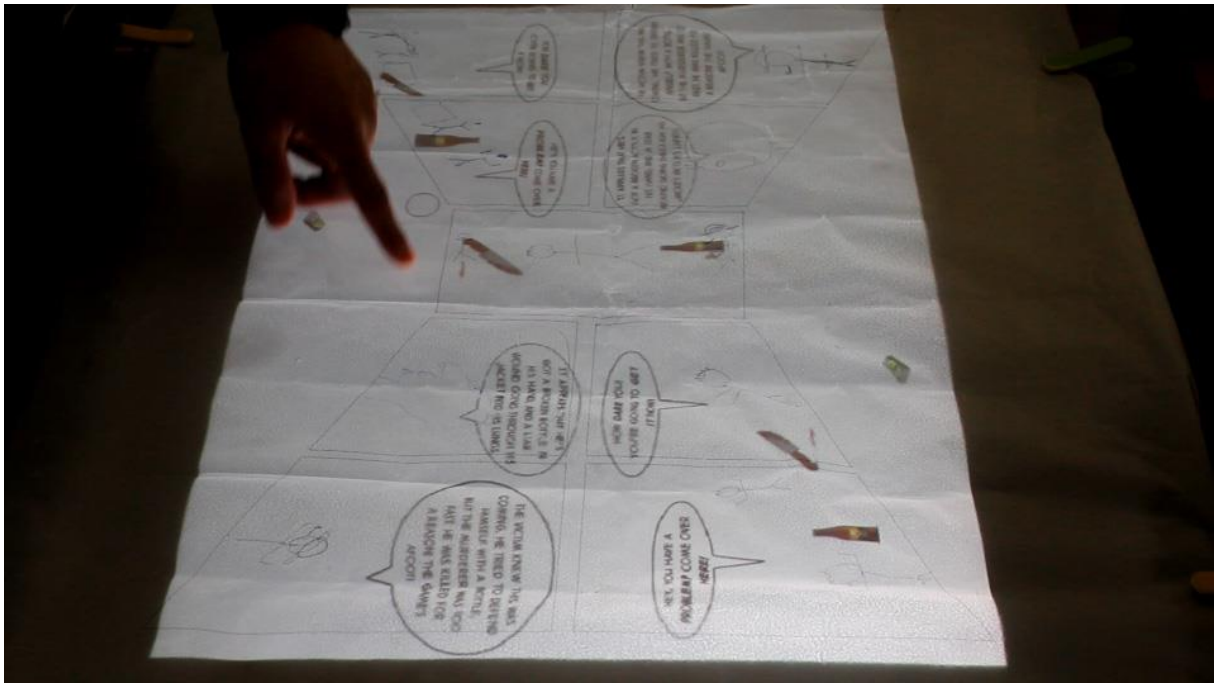


Figure 8.3.1.1 - The comic created by Group 1 (Participants 1 and 2)

When the remaining participants use this comic, they all struggle to make sense of the story due to the imbalance between the high level and low level information provided. As shown in Figure 8.3.1.1, the top level of the comic, drawn directly onto the paper, depicts rudimentary stick figures in a range of simple poses. The only character to have any distinguishing features is Holmes, whose trademark deerstalker and pipe enabled only one of the participants to recognise him. The low level projected information, on the other hand, is too detailed for the spaces provided, particularly when Holmes finds the potential case interesting. This means that the participants using the comic find the story difficult to follow, and require the authors to explain the narratives to them. When asked about the motivation for this design, the authors state that it is of interest to them to create a scenario in which the images could accommodate multiple narratives, and to have narratives with very different outcomes. The users of the comic agreed that, had the images and text been more legible, this design would have provided an interesting experience.

8.3.2 – Group 2 (Participants 3 and 4)

Participant 3 gives the equivalent details of the drawn level of the Old West comic as both participants in Group 1: it is identified that the setting is a bar, that one man threatens the other with a pistol, and that a "cop" intervenes. This participant also embellishes the drawn details with additional information, suggesting that the two individuals are there "to play cards or something", and that one man threatens the other "for something regarding money, or anything". Participant 4 gives much less specific information at this level: "From just looking at it, I'd say this guy [points at the spectacled man] is being threatened, there's a sheriff maybe threatening this guy [points at the cowboy] so he doesn't shoot the other one… but that's all I can tell".

Participant 3 experiences issues deciphering the outcome of the combined choices from the outset. This may be because, unlike the first group, these participants opt to give the spectacled man a pistol as part of the first combination. In the reading of this combination, the third participant's descriptions continually go back and forth between panels, attempting to construct a narrative that corresponds with the ambiguity of the images and text: "so he's always got the gun [points to the cowboy] or in this case he doesn't, because, like, he's holding the gun [points to man in spectacles] but there's another gun here [points to centre panel] so does that mean he's got the gun [points to the cowboy] or he's got the gun [points to opposing character]?"

The fourth participant is able to formulate a linear narrative relatively easily, describing what he interprets as being a situation wherein the cowboy is drunk and aggressive, but the spectacled man is able to shoot him first. However, this is not until after he overcomes some issues with the renderings of the projected material: "If you read it, it makes sense, but if you really go into deep, it's like… it's not awkward, but it's… something. Oh it's this guy who's thinking that isn't it? The bartender? It's so close that I thought this, that he is thinking that [points to the

cowboy].” Once this participant identifies which character the projected material should be assigned to, the construction of a narrative promptly followed.

The next two combinations picked are relatively straightforward, and the descriptions the participants provide accurately portray the intended designs. It is noted that, while the third participant gesticulates and make comments randomly between panels, the fourth participant provides more linear descriptions. The final combination, before both participants decide not to continue, again assigns the pistol to the spectacled man. In this case, however, the third participant is able to deduce the intended, authored relationship between the characters, objects and events, though with less confidence than the fourth.

The scenario these participants choose to create their comic around is that of two people having dinner in a restaurant. In this case, the characters in the restaurant are discussing the ransom for a kidnapping, and the different objects chosen are a pile of money, a ring, and a knife. A screenshot of the video taken of this comic can be seen in Figure 8.3.2.1. Depending upon what is chosen, the characters in this comic either resolve the situation or continue to debate it. For example, if the characters have either the money or the ring, the situation is resolved and the kidnapper would accept the offer and return the other character’s family to him. If either of the characters bring a knife then they are either demanding more money or for their family to be returned, depending upon the character.

The drawn level of the comic is more detailed than the previous group’s; containing rendered spaces for dialogue, thoughts and objects, as well as rudimentary details for the setting and the characters. When interpreting this level, all the remaining participants recognise the setting being depicted, and that the containers are intended to depict thoughts, dialogue and objects. The low level details of the dialogue and thoughts are much less detailed than the previous group’s, but contain sufficient information for most of the remaining participants to understand

the situation being described whilst using the comic. It is noted that one participant finds the logic hard to follow, but that the remaining participants are able to comprehend the results of the different outcomes, and the different roles that the characters corresponded to. For example: “Basically this guy’s got this guy’s family, right? Got them kidnapped, and he wants to exchange something valuable, and he’s like, of you don’t give it to me I’ll kill them”.

The one participant who struggles with the meaning of this comic is affected by the interface. Being able to see the consequences of dragging objects into the comic out of sequence (which is part of the system’s design, not the comic’s) affects how this participant wants to read it: “It’s unnatural to go from here [points to one section of the comic] to here [points to previous section]”. Although this participant does not provide an account of the sequence that is consistent with the designers’ and the remaining participants’, he is less confident in his description.

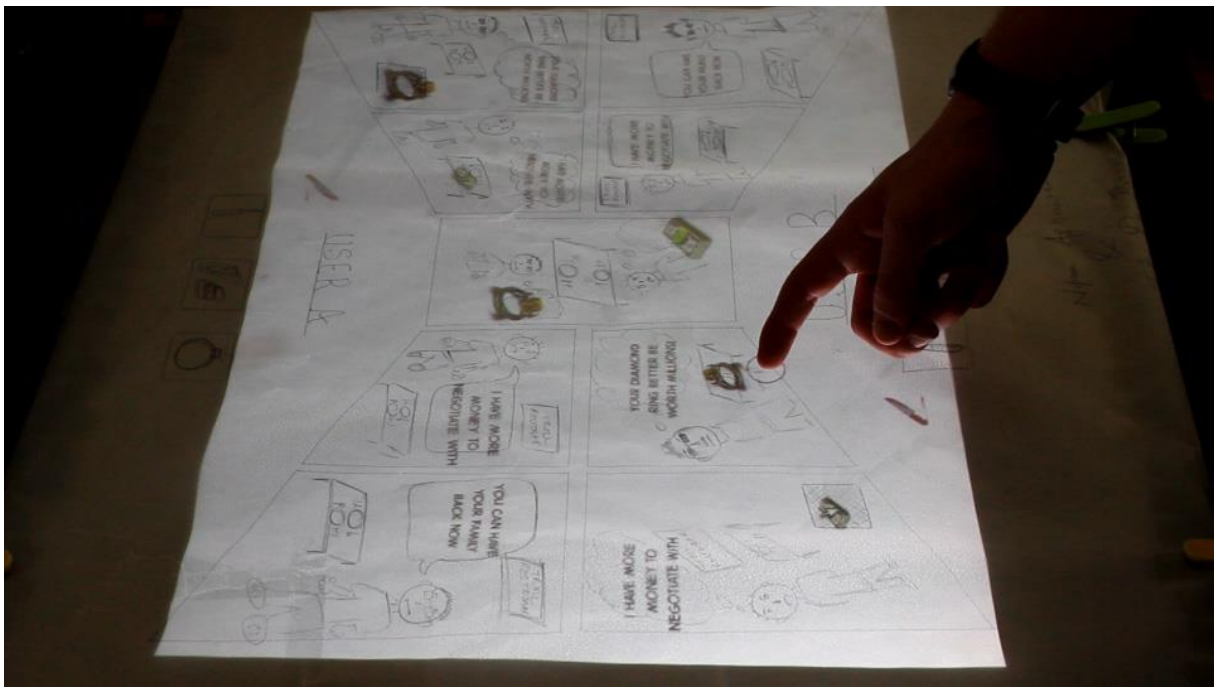


Figure 8.3.2.1 - The comic created by Group 2 (Participants 3 and 4)

When asked to explain the motivation for this design, the authors state that their story is designed to be simple, while still containing a range of possible outcomes. Participant 3 states that they have deliberately drawn spaces within the layout in order to compensate for any potential issues that might be experienced related to deciphering which character says or thinks each piece of information. The small amounts of dialogue are designed to convey information efficiently within the drawn images.

8.3.3 – Group 3 (Participants 5 and 6)

The interpretations of the drawn level of the Old West comic provided by participants 5 and 6 are similar to those provided by the preceding participants. Participant 6 embellishes the visual details in a similar vein to some other participants had previously: “I think these are two guys sitting in a bar playing maybe cards, having something, maybe gambling”. Participant 5 does not provide details about what the two men are doing prior to the cowboy drawing his gun, but is the first participant to assume that one of the men shot the other in the penultimate panel.

The first combination of objects these participants choose is a pile of gambling chips assigned to the cowboy and an Ace of Spades card assigned to the man in spectacles. The resulting descriptions from this combination are designed to convey that the cowboy, winning in a game of cards, spots that the spectacled man is cheating, and draws his weapon. Neither of the participants are able to deduce this from the description initially. Participant 5 is able to deduce that one of the players is cheating but does not understand why there is a standoff, given the cowboy is winning. Participant 6 agrees, until he realises that one of the thoughts of the background characters is describing the danger the spectacled man might face: “that guy’s winning again, so why would… oh hang on, ‘he could die if he cheats’ [quote from one of the thought bubbles of the background characters], so if that boy’s winning again, he’s going to

want to kill him, isn't it?" This is the same participant who finds it difficult to navigate the panels in the comic made by Group 2.

The second combination of objects these participants choose is the set of playing cards and a bottle of whisky; assigned to the cowboy and the spectacled man respectively. In this combination, the reason the cowboy draws on the spectacled man is deliberately left unclear. When the sheriff intervenes in the final panel, the dialogue balloon shows him saying "Why harm that helpless drunk?!" Neither of the participants is sure why the cowboy went "crazy", as participant 6 put it, but they are both able to follow that the sheriff stopped something worse from happening, and that this combination is "straightforward".

The next combination these participants choose is less straightforward; assigning the small pile of gambling chips to the cowboy and the gun to the spectacled man. Again, assigning the gun to the spectacled man alongside a pre-drawn rendition of the cowboy drawing a pistol causes confusion, though not as much as with previous groups. The designed outcome of this combination is that the sheriff calls out to the spectacled man, placing him under arrest for shooting a man without good reason. Participant 5 is able to identify this, but is not sure why this is happening: "looking here, 'why would he want to kill the pitiful looser?' I mean you won, there's no need to kill". Participant 6 is able to understand the situation by identifying with the spectacled character to which he is assigned: "So from the way things went on, I had a gun and I was thinking of shooting this player, but then he puts the money on the table, but I still shoot at him, and then the sheriff comes in and says why did I kill him. That's how the game went on".

The final combination these two participants read assigns a bottle of whisky to the cowboy and a pack of cards to the spectacled man. Both participants understand that the details are depicting a situation in which two men argue over a game of cards, and that the cowboy draws his weapon

because he is drunk. However, neither of the participants are particularly confident about their assessment from the available details. Participant 5 states, “those are the thoughts from the onlookers, but the gun, if he shoots, is something more questionable”, while participant 6 states, “I think I had a show of cards and then this guy… then the other guy took out a gun and he was about to shoot me and then the sheriff came in and… and calmed everything down. I think that’s what happened. Or maybe I’m reading it wrong”.

The scenario these two participants choose when creating their own comic is of two people dining in a restaurant. A screenshot of footage from the recordings of this comic is shown in Figure 8.3.3.1. The objects chosen are a ring, a bottle, and a phone. At the top level, a man and a woman are dining in a restaurant, which is identified by everybody reading the comic. Depending upon the items chosen, the couple are celebrating a proposal (ring), having a drink (bottle), or taking a picture of themselves (phone). However, the authors deliberately designed for the combination of options to not result in emerging dialogue in the final two panels, and the characters simply repeated themselves. This means that other participants using this group’s comic find the story easy to follow, but also find it strange that the dialogue repeated.

When asked to explain the justification for their design, this group states that they wanted to create an obvious scenario that is simple to understand. They also feel that having the dialogue repeat might alleviate any issues related to the navigation of panels. The remaining participants agree that this is accomplished, and that the images and dialogue are the most clear of all the comics produced. However, they also feel that this design choice is made at the expense of providing a satisfying narrative experience.

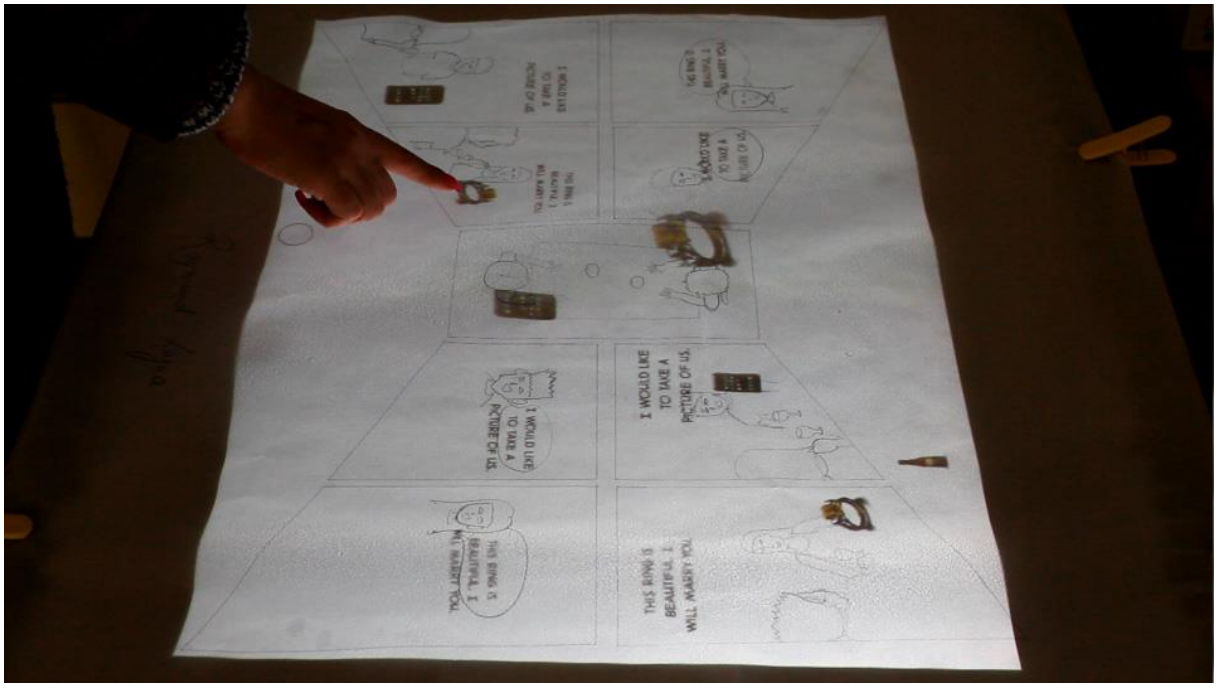


Figure 8.3.3.1 - The comic created by Group 3 (Participants 5 and 6)

8.3.4 – Group 4 (Participants 7 and 8)

Participant 8 gives an account in keeping with previous descriptions of the top drawn level of the Old West comic. Participant 7, however, gives a more embellished account, which deviates from any of the authored narratives of descriptions given by other participants: “I think he’s an investigator [points at the cowboy], he’s a wanted guy [points at the man in spectacles], and then the discussion goes wrong, and these are the consequences of the disagreement [points at the last three panels]”. This kind of embellishment is typical of this participant throughout the remaining interpretations of the story following interactions.

Participant 8 gives standard descriptions of the combinations subsequently explored. One of these combinations involves assigning the gun to the spectacled man, which had caused other users to experience difficulty interpreting the comic previously. Participants 7 and 8 express difficulty with the ambiguity of this combination regarding which character is the shooter in

the penultimate panel. However, Participant 7 attempts to make sense of this panel based upon information that is not given, as he does with the comic at its drawn level: “I think there’s an investigation, and the sheriff, I think he doesn’t know what’s going on between them. I think there’s an underlying meaning”. Similar descriptions are given with other combinations, such as with a pack of cards and a pile of gambling chips: “I’m thinking this game is not really what’s going on between both of them, there is an undercover discussion between them I think this [points at centre panel] doesn’t really mean anything, but the game is just like a cover-up, as I said, there is something going on beneath like a problem, so at the time, he says something [points at spectacled man], and that provokes him [points at cowboy], he brings out the gun, that’s what I’m thinking”.

The scenario these participants choose to base their own comic on is that of a doctor talking to a patient in a surgery. The objects they choose for their scenario are a bottle, a wrist watch, and some pills. An image of this comic can be seen in Figure 8.3.4.1. From the perspective of experience, other participants reading the comic have similar problems with the interface as experienced with the first group’s comic, in that the drawings are rudimentary at a high level, yet the information given is quite detailed at a low level. However, unlike the first group’s comic, the design for this scenario only has one possible outcome rendered in response to the objects being used, and only one combination results in this outcome. The participants involved in using this comic are therefore not sure how they are supposed to approach it, and the details they provide of the readings predominantly relate to this problem. When asked about the rationale behind the decision to create one outcome only, the authors state that they wanted readers to find the “correct” combination out of the possibilities, in order to uncover the “true” version of the story.

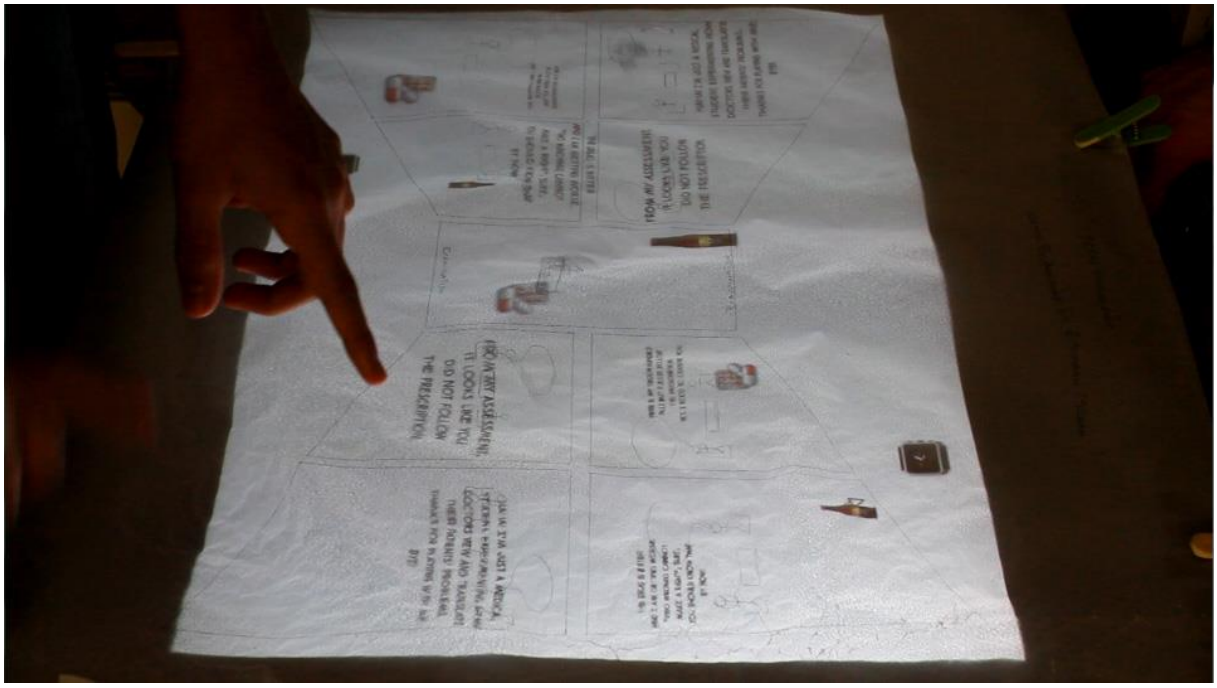


Figure 8.3.4.1 - The comic created by Group 4 (Participants 7 and 8)

8.4 – Discussion

It is apparent that an interface displaying all the combinations is not sufficient to encourage participants to explore all of these combinations. This is true of the comic designed for participants to use in the study and the comics they create themselves. In this case, a comparative study is not done between a paper comic showing all the combinations, which would need to be done in order to explore the validity of theories regarding the phenomenological differences between paper and screen. The causal distance between events and outcomes and the trend of goal-oriented readings, as identified in Chapters 6 and 7, has been accounted for in the Old West comic, which can inform the designs of future interactive stories. This may be at the expense of users being able to make sense of the narratives, however. The main issue that emerges in the interpretations is that of the ambiguity of the different narratives, particularly when the spectacled man is assigned a pistol. It could be that an

additional Release panel is needed to make sense of the structure, which explicitly shows who shot whom or not, as the case may be, following the Sheriff's declaration. Having ambiguous combinations exacerbates confusion over both the story and the interface. This is consistent with the findings of the thesis so far regarding the symbiotic relationship between user experience and comprehension in interactive stories.

The patterns of usage and comprehension are reflected in patterns of creating and using comics. The participants in the first group ultimately engage with the experience of using the Old West comic more than the other groups. The top level of the Old West comic is of least significance to them, whereas manipulating lower levels produced results they find interesting. This is reflected in the comic they produce, which contains creative and detailed combinations at a low level of abstraction. However, the imbalance between high level and low level information was not appreciated by the remaining participants.

The second group maintain a better balance in their created comic as a result of their experience of reading the Old West comic. Though they struggle more than the first group with the interpretations of the Old West comic, they respond to their own experiences and create a visual and textual experience that other participants can identify. For example, the use of dialogue and thought bubbles in the top level of the comic is a response to one of the participants having difficulty identifying who is being assigned dialogue and thoughts in the Old West comic.

The third group has the most difficulty using the Old West the comic, particularly the participant who struggles with the format of creating dialogue that may be out of sync with the order of panels depending upon which panel the object is assigned to. The story these participants present is consequently much easier to read, and avoids the problem of the reading order being affected through interaction by having the dialogue recurring between panels. However, the remaining participants feel that this results in a less interesting experience. The

types of users in the third group may therefore be more engaged with the sequential displays of panels and objects in interactive comics, such as the interface employed in the comic from Chapter 6.

By contrast, the final group produces a comic that is almost unusable for the remaining participants, but reflects the seventh participant's experience of using the Old West comic. Participant 7 is more investigative than other participants, and assumes that there is an underlying meaning behind the actions of the characters that is not revealed within the comic. When asked to justify the design of their comic, the participants in Group 4 explain that the 'true meaning' of their comic is revealed through the 'correct' sequence of options. For these users, the exploration of branches is therefore a method of investigating meaning, rather than experiencing different narratives.

8.5 – Conclusion

Following the previous studies, which identify trends in comprehensions and usage, this chapter shows specific examples of possible responses to using interactive comics, and how these could impact approaches to creating interactive stories. Further to the discussion of the dilemma of creating content with which users can interact, the work in this chapter reinforces the argument that user experiences can impact comprehension, and vice versa. The physical division of the comics into layers of abstraction facilitates the identification of different interpretations, and the experiences interaction with lower levels of abstraction can have upon these interpretations, whether reinforcing or conflicting with them. This is not only demonstrated in the interpretations and experiences of the Old West comic, but by the comics subsequently created in the same environment; wherein users learn the system of creating comics and design levels of abstraction based upon their experiences of interpreting and using them. While some

researchers in interactive stories struggle to accommodate the distinctions between user experiences and comprehension, this chapter demonstrates the symbiosis between these areas of study, which is exemplified through design processes. It is therefore noteworthy that, due to this symbiosis, the theories of role-play discussed in the preceding chapters can also contribute to established methods of evaluating interactive stories, in addition to understanding processes of designing and creating the stories themselves.

As shown in Chapter 4, there are many different phenomena that can be explored with regard to user experience and comprehension, and the present chapter reveals that there could be as many categories of designers as there are users. In the same way that Dow et al. (2007) finds that that there are many types of presence and engagement, and different categories of users respond to different types of presence in different ways, the present study demonstrates that different users can respond to different aspects of the same interactive comic in different ways. The methods employed in this chapter therefore complement those employed in the previous studies in the thesis, and in combination could be used in comprehensive evaluations of interactive stories.

CHAPTER 9: CONCLUSION

In opposition to some approaches to studying stories, and on the assumption that these theories aim to standardise conceptions of story comprehension, Moissinac (2004, p.234) states, "Are interpretations [of stories] not most valuable because of their variety and potentialities?" As shown in this thesis, such statements are based on misconstrued interpretations of the efforts of researchers to understand the complex cognitive processes involved in creating and using stories, including interactive stories. As shown in Chapters 2 and 4, academic approaches to stories involve the investigation of complex patterns in both the stories themselves and approaches to comprehending them. These have informed studies into interactive stories, where the dilemma of creating content with which users interact is reflected in the dilemma of choosing which aspect(s) of interactive stories to study.

From the designer's perspective, such approaches relate to proposed methods of creating and organising content for interactive stories, and this thesis uses the concept of abstraction levels (Aylett et al., 2008a, 2008b; Crawford, 2012) as a foundation upon which these various theories and methods are correlated. In Chapter 2, it is argued that proposed structures such as Aristotelian models of interactive story design (Mateas, 2001) story grammars or schema (Rumelhart, 1975; Mandler and Johnson, 1977) and game design methods such as foldback structures (Adams and Rollings, 2007; Crawford, 2012) can be aligned with levels of abstraction in interactive story designs and help creators decide where, how and to what extent users can interact with and influence stories. Following this analysis, Chapter 3 provides an in-depth investigation into how comics could help designers perform this role by aligning approaches to visual abstraction and story abstraction (McCloud, 1993), situation or mental models (van Dijk and Kintsch, 1983; Johnson-Laird et al., 1992) and visual narrative structures

(Cohn, 2013b) against levels of abstraction. This forms the foundation of the first contribution of the thesis in response to Research Questions 1, 2 and 4 as set out in the Introduction: that comics can be employed to design and visualise levels of abstraction in interactive stories, which can be aligned with hierarchies of story content. It is argued that this counters the limitations of previous approaches that may not be comprehensive, or that require additional representations to accommodate the variables and branches that are contained in interactive stories. In addition, the visualisation of story content within a framework of branches alleviates the problem of combinatorial explosion. It could be construed that this only serves to confirm Moissinac's (2004) concerns; as the scope of the approach applies to branching narratives specifically, which may not accommodate systems that respond to users, or the actions and interpretations of users themselves. However, subsequent chapters in the thesis demonstrate that the approach to design can also be integrated in evaluations, which accommodate the agency of the user and can be used to inform future designs and/or systems of interactive stories.

In order to counter any potential limitations of focussing upon content in a process for interactive story design, Chapter 4 proposes the use of interactive comics in evaluations of interactive stories, both as visualisations of responses and environments for exploring comprehension and user experiences. In the study in Chapter 5, it is shown that qualitative data could be used to inform the information that is assigned to levels of abstraction, which can conflict with designs. Though the comics can represent this information visually, the study shows that the categories within these visualisations need to be carefully considered based upon the context. Following this, Chapter 6 shows that, in conjunction with debriefings and observations related to user experiences, the visualisations of recollections of comics can show useful trends related to how users comprehend and experience interactive comics. These results show that patterns of using comics relate to both interactive stories and visualisations. In

addition to providing evidence in support of using branching comics to design and visualise interactive stories in response to Research Questions 1 and 2, this therefore provides evidence that comics can also be used in evaluations in response to Research Question 3. In response to Research Question 4, the range of phenomena that can be identified in visualisations of data and correlated with other qualitative data shows that comics have several advantages over other methods explored in Chapter 4, but there are some limitations related to identifying specific relationships of interpretations and user experiences, as well as identifying responses to specific levels of abstraction.

To counter these limitations, the final chapters of the thesis explore the development of an environment in which the levels of abstraction in comics can be physically divided, and responses can be obtained from small groups of users while they are participating with comics. This explores models of storytelling related to role-play, and it is shown that the same principles involved in modelling role-play in interactive story designs can be employed to evaluate interactive stories and explore the relationships between designs, experiences and comprehension. It is argued that the identification of these phenomena is facilitated by the separation of abstraction levels through the visualisation of content and interactions using comics.

As shown in Chapter 4, studies of stories and interactive stories tend to focus upon phenomena related to specific areas of user experiences and comprehension. This is an understandable limitation, given the range of phenomena that can be observed. The methods developed over the course of Chapters 5 and 6 can be continuously refined to explore specific phenomena, or be extended to be even more exploratory. While the visualisations employed in Chapters 6 and 7 can represent quantities of responses, they are less suitable for identifying specific relationships, whereas the methods employed in Chapters 7 and 8 are limited due to their

dependence upon greater volumes of qualitative data. In combination, the approaches provide an approach to evaluating interactive stories that is comprehensive. These approaches could continue to be refined in future work, or an alternative methodology that merges their advantages could be developed. Visualisations, for example, could be adapted to represent multi-dimensional aspects that incorporate data related to designs, comprehension and user experiences. Such an approach could be derived from the work of Eccles et al. (2008), which, as shown in Figure 9.1, uses a three dimensional view to portray events occurring in both time and space. The present work would contribute to the criteria of such visualisations, in the same way that the findings have progressively contributed to the sequence of studies in this thesis.

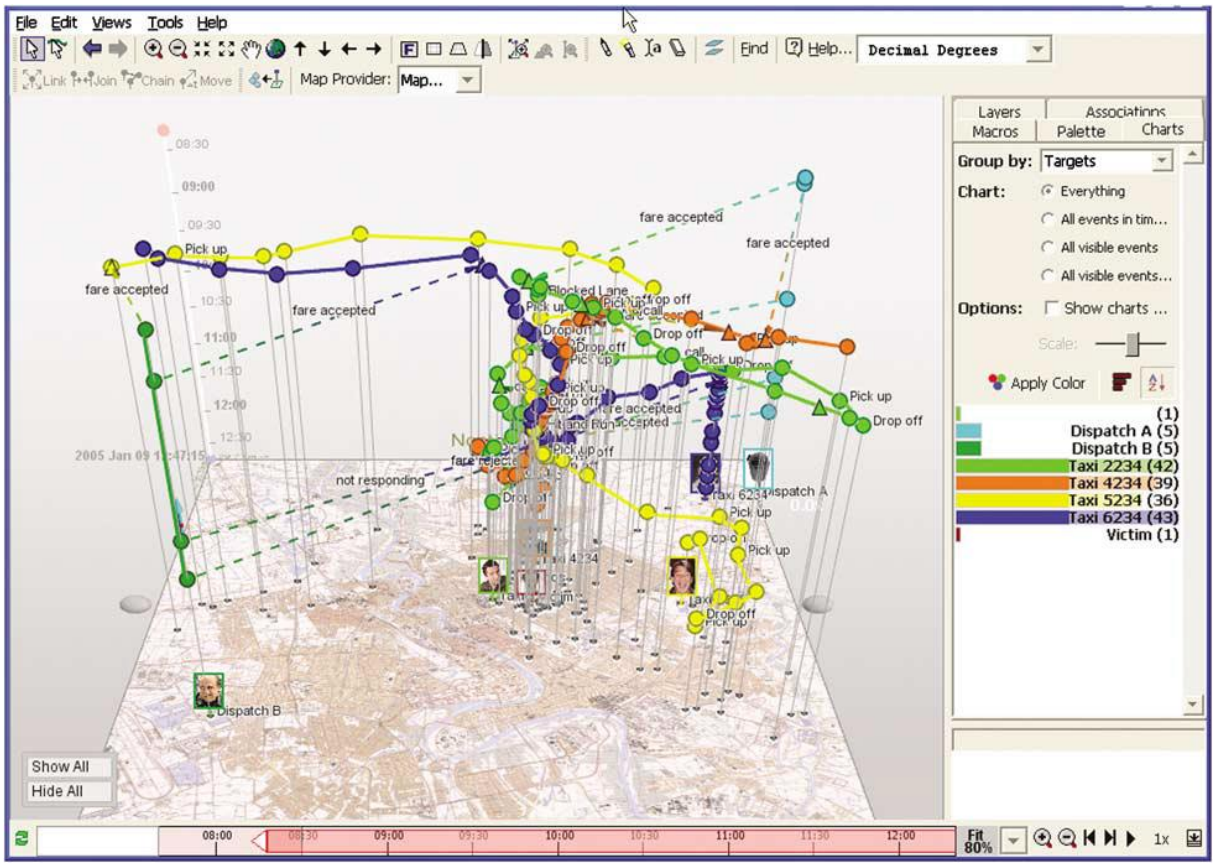
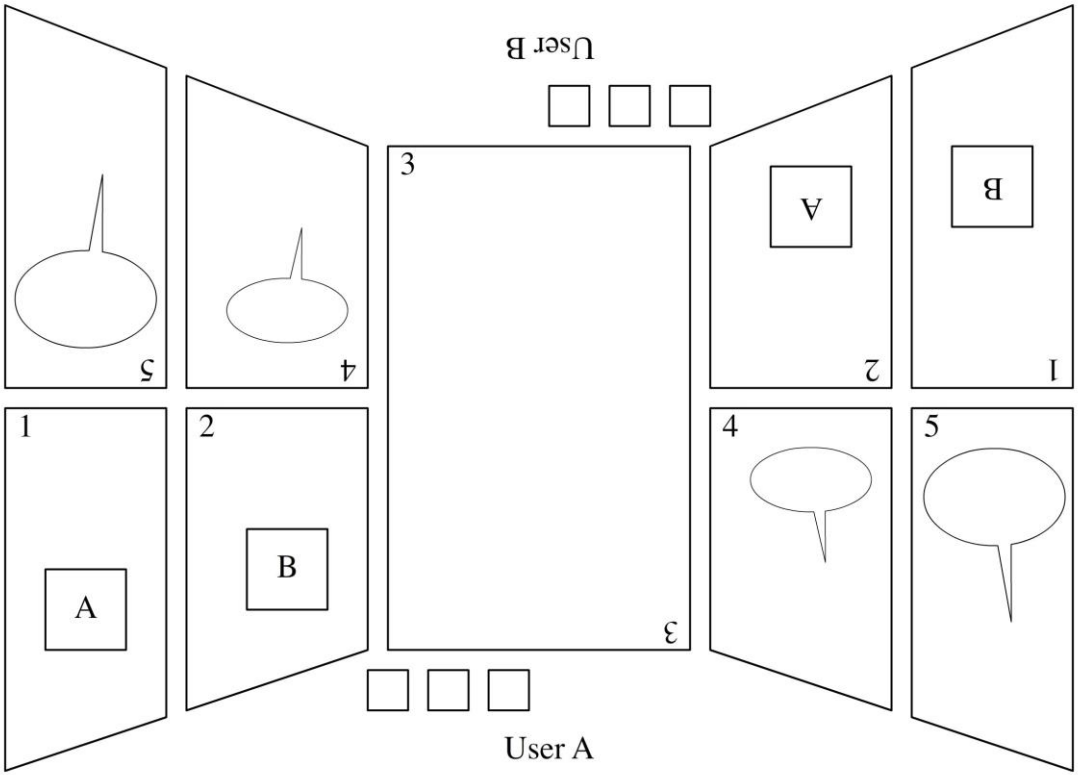


Figure 9.1 - GeoTime for analysis of events in time and space (Eccles et al. 2008, p. 5)

Employing branching narratives rather than emergent narratives, as specified in the Introduction, could be construed as a limitation. This could be an essential limitation when investigating processes related to designing story content rather than generating it. However, the findings of this thesis indicate that the approach to designing, visualising and evaluating interactive stories with branching comics has the potential to inform the design and development of systems that permit the emergence of narratives in interactive stories. The designs of the comics themselves are derived from theories of abstraction levels related to artificial intelligence in systems that create emergent narratives. Therefore, the visualisation of these levels can be used to plan the delivery of emergent narratives in such systems. In addition, the results of the studies in the thesis illustrate the range of narratives that can emerge in responses to interactive stories. While these responses are used to inform designs of branching narratives in the context of this thesis, they could equally apply to the designs of systems that perform this function as well. In the same way that designs have been refined, and could continue to be refined, based upon the studies in this thesis, systems that generate story content could refine themselves using patterns identified in the present findings.

Therefore, in addition to designing, visualising and evaluating branching narratives, interactive comics can be employed to explore potential systems for creating emergent narratives. As the process delivered in this thesis is derived from approaches to emergent narratives, it can be surmised that branching comics would complement existing theories and methods. Further studies would confirm whether interactive comics present the same advantages to studies of emergent narratives as those observed in relation to branching narratives in the present body of work.

APPENDIX : DESIGN DOCUMENT TEMPLATE FOR A MULTI-USER INTERACTIVE COMIC



This is the template you have been given.
User A and User B read the comic from left to right. You can see from this picture that User A's Panels are numbered 1-5. If you turn the page upside down then you will see that User B's panels are also labeled. Each user has spaces for 3 objects.
As you can see, Panel 3 is shared between both users; so both of the users should be able to 'read' this panel. In the Old West comic you used, this panel was a top-down view of the characters in the bar, and it showed the objects you used during the reading. In your comic, it will be a similar view of the characters involved in your story.
The characters in the story are characters A and B. The boxes A and B show where you can see these characters in your story. User A can assign an object to character A and User B can give an object to character B. When User A or B give their characters objects, the objects will be shown in the corresponding panel for the other user.
Panels 4 and 5 show the outcome of the characters' chosen objects. Anything can happen in these panels!

Choose **one** of the following scenarios.

1. Two people are having dinner in a restaurant
2. A Police officer is interviewing a witness at a police station
3. A doctor is talking to a patient in a surgery

You will need to draw your story on the template provided. Do **not** draw any dialogue or sound effects. **Remember to leave room for the projected objects, dialogue and sound effects in each panel.** You can add 1 other character in panel 4 and/or 5 if you want to.

Choose **three** of the following objects to put in your scenario. Do **not** draw these.

- Bottle (with liquid in)
- Knife
- Mobile/Cell Phone
- Money
- Pills
- Ring
- Wrist Watch

Use the following tables to design what happens when your users interact with your story.

In the first table, you can write down what happens in the first 2 panels when your users are choosing their objects. Write down which objects you have chosen for your scenario in the column 'Objects', then in the adjacent columns write down what the characters will say when your users drag the objects onto them.

As there are 6 possible combinations of objects, there are **6 different outcomes** for your story. Use the next 2 tables to define the outcomes of your story in panels 4 and 5. You will have drawn the basic events on your template, but now you need to think about how these might change. For example, in the Western comic the gun either went off or it didn't in Panel 4 depending upon which combination of objects had been assigned. Perhaps one of your characters will say or do something unexpected?

Object	Character A Dialogue	Character B Dialogue

Outcome in **Panel 4**		**Character A**		
		Object 1:	Object 2:	Object 3:
Character B	Object 1:	X		
	Object 2:		X	
	Object 3:			X

Outcome in **Panel 5**		**Character A**		
		Object 1:	Object 2:	Object 3:
Character B	Object 1:	X		
	Object 2:		X	
	Object 3:			X

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